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# Engineering and Contracting

Devoted to the Economics of Civil Engineering Design
and to Methods and Costs of Construction

# INDEX

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## GENERAL INDEX

The figures in parenthesis refer to page numbers of specialized monthly issues.

A

Aberthaw Constructon Company, Concrete Ship Yards (97) 383
Abrasion Tests on Bed Rock (5) 5
Abutments, Concrete, Breaking Up with Dynamite (104) 490
Accidents in Building Industry (100) 386
Accident Prevention, Construction Work (53) 299
Accident Prevention in Contracting (65) 311
Accident Prevention Methods of Fred T. Ley & Co. (55) 301
Accident Prevention in Quarry Operation (11) 59
Accident Reduction, Precautions (85) 371
Acidity in Sludge (96) 462
Activated Sludge Fertilizing Value of (7) 31
Activated Sludge, Worcester, England, Experiments (26) 122
Advertising by Architects (14) 86
Advertising Engineers (51) 229
Advertising by Engineers and Builders (91) 377
Advertising Proposal, Art of Writing (73) 317
Aerial Cableways, Handling Plates at Shipyards (96) 382
Aeriation, Improvement of Hydrogen Sulphide Water (101) 467
Air Compressor, Selection (126) 578
Air Plant, Selection of Compressor (126) 528
Air Drills, Repairing Vise for (126) 598
Air Drill, Socket Extractor (126) 598
Air Lift for Handling Sand (36) 194
Airplanes, Lumber Required (25) 206
Air Supply, Pilfered for Pneumatic Tools (84) 370
Air Tool Devices (126) 598
Air Transmission, Rock Drill Efficiency (82) 368
Alexandra and Hughes Docks, Bombay (39) 135
Algae, Control and Irrigation Canals by Copper Sulphate (128) 558
Algal Growths and Chlorine Treatment of London Waters (20) 414
Alkali, Soil, Effect on Concrete (97) 503
Alum Process, Water Purification (5) 399
American Association of Engineers (109) 453
American Association of Engineers, Directory (65) 289
American Association of Engineers of Local Societies (25) 206
American Federation of Labor, Draftsmen (49) 227
American Industries on Industrial Readjustment (114) 566
American Shipbuilding During War (97) 503
American Soc. C. E. Committee on Development (95) 381
American Society, Readjustment Committee (1) 49
Ant-Hills and Railway Construction in Africa (38) 134
Arch Dams, Grouting Contraction Joints (12) 36
Architects, Advertising by (14) 86
Architect and Engineer (90) 496
Architects and Structural Engineers (2) 74
Architects and War Work (102) 508
Arkansas River Valley Irrigation Pumping (5) 29
Army Cantonments, Sanitary Aspect of Water Supplies (94) 460
Army, Demobilizing (90) 456
Ash Collection, Cost, Philadelphia (81) 347
Asphalt Industry, 1917 (19) 19
Asphalt Mastic Shop Floor (22) 94
Asphalt Pavements Construction (9) 9
Asphalt Pavement Construction, Rainy Weather (124) 528
Asphalt Pavements Design (9) 9
Asphalt Pavement, Maintenance Cost, Buffalo (104) 448
Asphalt Pavement, Repairing, Buffalo (102) 446
Asphalt Shipped in Gondolas (8) 80
Asphalt, Standardization of Consistency (93) 437
Asphaltic Concrete, Constructed with Mixer (6) 6
Assessing System Includes House Survey (63) 241
Automatic Superdam (61) 263
Automobiles, United States (18) 18
Auto Crossing for Line Fences (33) 145
Axes, Old, Utilizing (60) 284

B

Backfilling with Steam Shovel (129) 559
Bacterial Removal in Filter Plants (80) 346
Barge, Electrically-Welded, The First English (22) 416
Barges, Concrete, Aberthaw Construction Co. (97) 383
Base, Slag, Brick Pavement (122) 526
B. Coli, Tests for California (20) 44
Beams, Grillage Bending Moments (113) 585
Beams, Pre-Cast, Pacing 52 Ton (14) 86
Beams, Rein. Con., Continuous Design (115) 588
Bills, Electric Delivering (51) 253
Bill, Form for Light and Power (116) 546
Bill, Postal Card, Water (128) 558
Bills, Water (78) 344
Bituminous Coal, Stocking (6) 54
Bituminous Concrete, Maintenance of (99) 443
Bituminous Cushion for Wood Block (7) 7
Bituminous Filler, Proper Method of Application for Créosoted Wood Block Pavements (76) 320
Bituminous Macadam Constructed with Concrete Mixer (6) 6
Bituminous Macadam Shoulders, Concrete Road (129) 533
Bituminous Materials, U. S. Highways Council Policy (75) 319
Bituminous Pavements, Concrete Bases (96) 440
Bituminous Pavements, Recent Practice in (30) 142
Bituminous Surfaces, York County (37) 149
Blasting, Calculation of Charge (119) 571
Blasting, Chamber Methods and Costs (55) 279
Blasting Down Clay Bank (8) 56
Blasting with Electricity, Precautions (125) 577
Blasting Gelatine, Efficiency of (11) 107
Blasting, Ice Gorge (59) 283
Blasting, Igniting Fuse (21) 69
Blasting, Methods of Preparing Ground (38) 196
Blasting Stumps, Frozen Soil (106) 492
Blasting, Well Drilling Method (52) 276
Block-Holing (38) 196
Boilers, Saving of Coal by Covering (108) 514
Bonna System, Reinforced Concrete Pipes) (21) 117
Bonus Payments, Engineering Council (3) 51
Bore Hole, Device for Pulling Drive Bar (123) 575
Boulder, Colo., Commission Manager Plan (1) 26
Boulder Deposits, Sampling (8) 8
Boulders, Blasting Without Drilling (13) 61
Boundary Waters, Pollution of (93) 459
Breakwater, Compound Type Gibraltar (25) 121
Breakwater Construction, Concrete Caissons, Trapezoidal Section in (75) 361
Breakwater Construction, Racine, Wis. (75) 361
Breakwater Models to Determine Wave Action (27) 123
Brick Building, Blasting Down (107) 493
Brick Masonry, Breaking Up with Dynamite (106) 512
Brick Pavement, Monolithic, Labor Cost (68) 246
Brick Pavement, Slag Base for (122) 526
Brick Piers, Strength of (106) 512
Brick Pavement, Tar Concrete Foundation (74) 318
Brick Paving, Vermilion County, Output of Gang (57) 235
Brick Sewer, Labor Cost (65) 267
Bridge Approaches, Non-Slip Paving for (68) 246
Bridge Construction with Timber, Concrete and Stone (107) 393
Bridge Design, Reinforced Concrete Slab (93) 499
Bridge Designing, Reviving Competition in (89) 375
Bridge Design, Standardization of Detail (107) 513
Bridge, Hell Gate Arch, Rivets and Riveting (108) 194
Bridge, Menai Suspension, Tests on Tie Bars (29) 423
Bridge, Method of Strengthening (11) 405
Bridge Pier, Mystic River Construction (102) 508
Bridge Work, County Engineering Cost (60) 238
Bridges, County Numbering (41) 221
Bridges, Flat-Slab Construction (31) 211
Bridges, Lessons of War (29) 433
Bridges, Load Investigation (122) 594
Bridges, Old Railway, Method for Investigation (122) 594
Bridges, Painting, Steel, Cost (110) 454
Bridges, Railway, Strengthening (125) 597
Bridges, Reinforced Concrete Pre-Cast (12) 108
Bridges, Vertical Lift, Mechanical Features (95) 501
British Engineering Review Issue (1) 9
British Industries, Effects of War on (14) 409
British, Laboratory for National Research (29) 423
British Railways Under War Control (6) 400
British Shipyards, Pneumatic Riveting in (10) 404
Broken Stone Cost, 1917 (128) 580
Broken Stone, Standardization of Screen Opening for (88) 332
Broken Stone, Test Values (46) 158
Buffalo, Construction Concrete Pavement Base (126) 530
Buffalo Plans, Post War Improvements (105) 449
Buffalo, Street Cleaning at (100) 445
Building Construction Industry National Convention (4) 2[illegible]
Building Construction, War Industry Board (108) 514
Building Industry, Accidents in (100) 386
Building Industry, Reconstruction (116) 568
Buildings, Mill Wood (45) 225
Building Office Design (40) 220
Building Operations, Cost $450,000,000 (107) 513
Buildings, Quantity Surveys for (101) 507
Building, Reinforced Con., Working Model Forms for (94) 380
Building Stone Preserving (2) 396
Building Stone Production, 1917 (118) 570
Building Work, Ratio of Labor and Material (4) 100

1531
1|1

Building Work, Emergency War Department . . . ...............(23) 95
Building, Wrecking with Dynamite.(101) 487
Buildings, Office, Depreciation....(116) 588
Buildings, Office, Economic Life of.(37) 217
Bulk Cement Shipped in Gondolas..(8) 80
Bureau of Standards, Stucco Tests.(101) 387

C

Cable Drilling ......................(38) 196
Caissons, Concrete, Trapezoidal, Section Breakwater .............(75) 361
Caissons with Concrete Bottoms for Pier Construction ...........(102) 508
Caisson Pneumatic, Halifax.......(103) 489
Calaveras Dam Failure.............(2) 26
Camp Bowie, Tex., Malaria Prevention Work ....................(58) 260
Camp Sanitation ...................(38) 134
Canal, Irrigation, Measurements, Methods . . . ......................(113) 543
Canal, Niagara Falls, Excavation Methods . ........................(120) 572
Canals, Irrigation, Algae Control..(128) 558
Canals, Drainage, Maintenance.....(31) 167
Cantonments, Sanitary Aspect of Water Supplies ....................(94) 460
Capital Issues Committee and Public Work Bonds . . .............(91) 497
Car Tracks, Removing Ice from....(5) 5
Car Unloader, Spare Tower Hopper for ...............................(6) 6
"Case Method" of Teaching Engineering .........................(127) 557
Cast Iron Pipes, Standard Specifications .........................(36) 430
Catch Basin Cleaning with Orange Peel Bucket . . .......................(33) 169
Catalogs, Standardization of.......(72) 338
Cement Bag Holder or Mixer......(131) 535
Cement Draintile, Alkali Soil.......(98) 504
Cement, Fuel Restrictions.........(108) 494
Cement, Setting Action of.........(8) 80
Central Avenue Bridge, Kansas City.(4) 76
Centrifugal Force and Reaction...(28) 208
Chamber Blasting .................(38) 196
Chamber Blasting Methods and Costs ...............................(55) 279
Charcoal Corners Set by Surveyors ..............................(113) 565
Check Dam, System of Stream Control . .........................(73) 339
Chemicals, Water Treatment, Cost . . . .........................(100) 466
Chicago Engineers, Salaries of....(51) 229
Chimney, Method of Felling......(34) 428
Chlorine Treatment of London Waters . ..........................(20) 414
City Managers' Association..........(2) 2
City Manager Field, Recent Developments . . ......................(86) 353
City Manager Plan, Progress......(101) 487
City Engineer's Annual Report....(73) 317
City Engineers and Street Cleaning(25) 137
City Planning for Small Municipalities . . ........................(64) 242
Civil Engineers Formulate Policies Municipal Improvements .........(3) 27
Civil Engineers Should Operate Sewage Plants ...................(3) 27
Civil Engineers in War Work......(89) 375
Clay Bank, Blasting Down.........(8) 56
Clay Products, Fuel Restrictions..(108) 494
Cleaning Smoke Stacks.............(50) 274
Clerks, Government, Working Conditions . . .......................(28) 186
Cleveland Engineering Society Amends Constitution . . ..............(105) 391
Clinker vs. Gravel as a Nidus.....(5) 105
Clippings, Filing from Engineering Papers . ........................(50) 252
Clock System, Numbering Highways . . .......................(36) 148
Coagulants vs. Sand Filters, Water Purification . ..................(5) 399
Coal, Bituminous, Stocking..........(6) 54
Coal Burning, Practical Rules.....(105) 471
Coal Dust, Fine Slack for Fuel..(92) 378
Coal, Frozen, Loosening with Pneumatic Tie Tampers...............(11) 59
Coal Requirements, U. S...........(68) 270
Coal, Saving by Bonus Payments to Firemen . ....................(48) 250
Coal, Saving by Covering Boilers.(108) 514
Coal, Saving of by Metering Water.(89) 455
Coal Slack, Utilization of as Fuel..(9) 105
Cofferdam for Repairing Vessel..(127) 579
Cofferdam Timber, Rapid Building.(59) 283
Coffer Dam, Troy Lock.............(59) 283
Cold Water, Concreting............(37) 133
Cold Weather Concreting.........(122) 594
Cold Plate Bending Machine.......(53) 299
Coleman Du Pont Concrete Road, Method of Handling Aggregates.(108) 452
Colleges to Train 200,000 Young Men for Officers . . ...............(47) 249
Colors, Effect of Temperature on..(44) 224
Combustion, Spontaneous Waste Causes ............................(22) 118
Commission Manager Form of Government . . ......................(102) 488
Commission Manager Plan, Boulder, Colo. . . ........................(1) 26
Commissions, Public Service.......(47) 271
Committee on Development, American Society C. E.................(95) 381
Community, Irrigation Plan.......(92) 458
Compressed Air Sewage Lifting System, Cairo ...................(18) 114
Compressed Air Terms ............(45) 203
Compressive Strength, Gunite.....(119) 591
Compressor, Selection ............(126) 578
Concrete Abutments, Breaking with Dynamite . . ....................(105) 490
Concrete Aggregates, Handling with Trucks . . ......................(56) 234
Concrete Aggregates, Washing and Screening ...................(103) 447
Concrete Aqueduct, Station Work on . . . ............................(76) 342
Concrete Barges, Method of Construction by Aberthaw Company...(97) 383
Concrete, Bituminous, Maintenance Cost . . ........................(99) 443
Concrete Bases for Bituminous Pavements . . ......................(96) 440
Concrete Base, Pavements, Constructing . . ........................(126) 530
Concrete Base for Pavements, Gang Organization ..................(126) 530
Concrete Building, Construction Forms for . ..........................(40) 136
Concrete Caissons, Breakwater ...(75) 351
Concrete in Cold Weather..........(94) 380
Concrete Design Approach to Central Avenue Bridge ...............(4) 76
Concrete, Determination of Voids..(29) 125
Concrete Disintegration, Concrete.(97) 503
Concrete Extension, Ore Dock, Superior . . ........................(4) 52
Concrete Flat Slab Construction Bridges . . ........................(31) 211
Concrete Bins, Construction Method . . . ........................(101) 507
Concrete, Light Weight for Ship Construction .....................(27) 207
Concrete, Light Weight for Ships..(42) 222
Concrete Mixer, High Drum "Non Tip" . . . ...........................(22) 22
Concrete Mixes, Basic Principle of..(5) 77
Concrete Mixes, Role Played by Water . . . ...........................(5) 77
Concrete Pavement, Crew Organization . . . . .........................(76) 320
Concrete Pavement, Expansion Joint Installer . . ...................(133) 537
Concrete Pavement, Kenilworth, Ill. . . . ..........................(97) 441
Concrete Pavement, Method of Raising Sunken Slabs ...............(105) 449
Concrete Pavement, Reinforced for Circumferential Rods ..........(102) 446
Concrete Pavement, Removing Soft Spots . . . ......................(48) 160
Concrete Pavement, Rolling 2-inch Pipe . . . .........................(63) 241
Concrete Pavements, Vertical Movements . . . ......................(97) 441
Concrete Paving on River Banks...(54) 278
Concrete Paving, Rolling with 2-inch Water Pipe ..................(63) 241
Concrete Piles, Precase Driving....(53) 299
Concrete Piles, Saving of Steel......(5) 76
Concrete Plant, Kansas City Viaduct . . . . ..........................(11) 83
Concrete, Proportioning by Surface Areas of Aggregates .........(59) 305
Concrete, Quantity of Water for..(128) 532
Concrete Road Bed, Northern Pacific . . . ............................(7) 55
Concrete Roadbed for Railways....(11) 563
Concrete Road Construction in Cold Weather . . ......................(35) 147
Concrete Road Construction, Caring for Traffic .....................(115) 519
Concrete Road, Finishing Machine for . . . ............................(67) 245
Concrete Road, Maintenance Methods Wayne County .............(115) 519
Concrete Roads Maintenance in Milwaukee County ..............(21) 21
Concrete Road Practice, Wayne County ...........................(107) 451
Concrete Road, Repairing Uneven Joints .........................(63) 241
Concrete for Repairing Wooden Ships . . . . ..........................(112) 584
Concrete for Resurfacing Wornout Pavements ....................(21) 21
Concrete Road, 2-slab Method Construction ......................(20) 20
Concrete Road, Widening, Bituminous Macadam Shoulders ........(128) 532
Concrete Roads, Cracking..........(39) 151
Concrete Roads, Curing...........(108) 452
Concrete Roads, Direct Loading of Aggregates ....................(108) 452
Concrete Roads, Finishing by Pavement Planer Method ..............(74) 318
Concrete Roads, Finishing, Specifications for Roller and Belt Method . . . . . .........................(86) 330
Concrete Roads, Hydrated Lime Construction .....................(85) 329
Concrete Roads, Southern California Finishing Method ..........(100) 444
Concrete Ships, Construction Features of .........................(57) 303
Concrete Ship, Design, Features of.(16) 88
Concrete Ship "Faith," Strains Used for . . ..........................(105) 391
Concrete Test Cubes, Causes of Failure ..............................(117) 521
Concrete, Transportation by Compressed Air ....................(3) 75
Concrete Water Mains, Service Connections .....................(103) 469
Concreting, Cold Weather..........(37) 133
Concreting Cold Weather.........(122) 594
Connecticut Practice, Snow Removal Highways ...................(116) 520
Constitution for New National Association of General Contractors . . . .........................(102) 388
Construction Camps, Sanitation of.(50) 274
Construction Contracts, Expediting by Visible Record System.......(11) 83
Construction Division, U. S. War Department, Work.............(115) 567
Construction Equipment, Safeguarding . . . . . .......................(43) 201
Construction Work, Accident Prevention in ........................(53) 299
Continuous Rein. Con. Beams, Design ... . ..........................(116) 588
Contour Pavement Obtained Without Use of Strikeboard...........(62) 240
Contract, Cost Plus...............(124) 576
Contract, Highway, New Form....(29) 187
Contract Road, Massachusetts Cost Plus ..........................(14) 14
Contracting, Accident Prevention in . . . ............................(65) 311
Contracting Roads, Hazards, N. Y..(51) 229
Contraction Joints, Arch Dam Grouting ....... . . ...................(12) 36
Contractors Plant, Rental Prices...(99) 485
Contractors in War Work.........(89) 375
Contracts, Cost Plus...............(30) 210
Contracts, Cost Plus, Advantages..(66) 312
Contracts, Cost Plus Profit and Bonus for British Shipbuilding......(19) 413
Contracts, Highway, Outagamie County ...........................(38) 150
Contracts, Highway, Virginia.......(53) 231
Contracts, Profit or Loss Sharing Agreement ....................(53) 231
Conveyors, Applications for Handling Materials ....................(83) 369
Conveyor and Steam Shovel for Quarry Stripping ..................(113) 565
Convict Labor, Milwaukee County.(24) 24
Convict Labor, Road Work, Mo...(58) 236
Copper Sulphate for Control of Algae Canals ....................(128) 558
Core Type of Reinforced Concrete Floor Construction ................(12) 84
Corners, Charcoal, Evidence of....(113) 565
Corporation Cocks, Loss of Head in .............................(56) 258
Corrosion, Elimination of, in Hot Water Supply Pipe ..................(51) 297
Corrosion, Iron and Steel, Causes.(127) 599
Corrosion of Iron Work, Prevention . . . ...........................(40) 434
Corrosion of Steel Wharves.........(8) 104
Cost Keeping, Highway...........(109) 453
Cost Keeping, County Highway Work ... . . ..........................(33) 145
Cost Keeping of Motor Trucks....(42) 154
Cost Plus Contracts, Advantages.(66) 312
County Bridges, Method of Numbering ...............................(41) 221
County and City Manager Plan....(25) 137
County Highways, Cost Keeping...(33) 145
County Managers ..................(25) 137
County Roads, Iowa, Costs.........(68) 246
County Road Work, Engineering Cost of ...........................(60) 238
Creed, Engineers .................(10) 453
Creosoted Wood Block Pavements, Proper Application of Bituminous Filler for ....................(76) 320
Creosoted Wood Water Tanks for Railway Service ..................(44) 202
Cribs, Reinforced Concrete.........(98) 484
Crossing Auto for Line Fences....(33) 145
Crown Reducing Excessive on Macadam . . . ...........................(32) 144
Croydon, Sewage Disposal Experiments ...............................(19) 413
Crushed Rock, Handling with Self-Feeding Bucket Loader......(128) 532
Crushed Rock, Production, 1917..(128) 580
Crushed Stone Production, 1917..(118) 570
Crushed Stone, Standard Sizes, Standpoint of Producer............(129) 533
Crushed Stone Stock Pile, Determining Whether It Pays..............(3) 51
Coupling, New Expansion.........(66) 268
Cubes, Concrete, Failure..........(117) 521
Culvert, Drop Inlet, New Type....(67) 245
Culverts, Flat Top, Railway Practice ....... . .......................(105) 511
Culverts, Rubble Masonry.........(107) 393
Curb, Integral Form................(41) 153
Curve, Widening for Motor Traffic.(114) 518
Curves, Life of Rail on............(93) 479
Curves, Superelevations, Offsets for Paved Highways ............(58) 236
Cuts, Pavement with Pneumatic Drill ....... . . ......................(106) 450

D

Dams, Arch, Grouting Contracting Joints . . .......................(12) 36
Dam, Calaveras Failure............(2) 26
Dam, Concrete, Troy, Keying......(30) 188
Dam, Medlow, New South Wales...(17) 113
Dam, 236 ft., Murrumbidgee Irrigation Project .......................(10) 106
Dam Tilting, Gun Powder River Water Supply ........................(61) 263
Dams, Derwent and Howden......(2) 396
Deep Well, Recovering Pump from.(64) 266
Definition of an Engineer..........(112) 516

Definition, Structural Engineer....(109) 581
Demobilizing Army, Length of Time....(90) 456
Depreciation of Office Buildings...(116) 588
Derricks, Special Type Lock Wall Construction....(40) 198
Derwent Dams....(2) 396
Dewatering Sludge by Consolidation....(100) 467
Dionic Tester in Water Works Service....(16) 40
Directory, American Association of Engineers....(65) 289
Ditcher, Loading with Rails....(72) 358
Ditching, Railway....(76) 362
Disintegration, Concrete, Causes...(97) 503
Divers, Shaft Sinking....(19) 67
Docks, Alexandra and Hughes, Bombay....(39) 135
Docks, Madras Harbor....(40) 434
Dock, Ore, Superior....(4) 52
Draft, Engineering Students....(3) 75
Draft, Engineering Students....(26) 138
Drafting, Medical Profession....(26) 162
Drafting Room Errors, A Study of.(92) 378
Draftsmen, Causes of Unrest....(52) 230
Draftsmen, Salaries of....(52) 230
Draftsmen Union....(49) 227
Drag Line Excavator and Back Filler....(67) 291
Drainage Canals, Maintenance....(31) 167
Drainage Districts, Levee Construction for....(86) 352
Drainage, Vital with Heavy Traffic Growth....(86) 330
Drainage, Mississippi Valley Land..(2) 26
Drainage Operations, New Zealand.(31) 127
Draining, Zuider Zee....(31) 425
Draintile Cement, Alkali Soil....(98) 504
Drawbridge, Pontoon....(50) 296
Drill, Air, Repairing Vise for....(126) 598
Drill, Little Giant Corner....(107) 493
Drill Holes, Removing Debris....(112) 564
Drill Bits, Proper Forming and Treatment....(76) 362
Drill Bits, Selecting, Forging and Tempering....(31) 189
Drill Steel, Sharpening Shop for....(31) 189
Drill Steel, Pneumatic Punching Device for....(24) 72
Drilling, Efficiency Increase by Proper Forming and Treating of Bits.(76) 362
Drilling Rig Mounted on Rollers....(7) 55
Drills, Pneumatic for Pavement Cuts....(106) 450
Drive Bar, Device for Pulling....(123) 575
Drop Inlet Culvert....(67) 245
Dump Body, Automatic for Small Trucks....(90) 384
Dump Cars, Systematic Oiling of..(42) 200
Dynamite for Blasting Brick Building....(107) 493
Dynamite for Breaking Up Brick Masonry....(106) 512
Dynamite, Breaking Up Concrete Abutments with....(104) 490
Dynamite, Digging Pole Holes....(60) 284
Dynamite, Wrecking Building....(91) 487
Dynamiting Wells....(103) 469

E

Earth Pressures, Experiments....(21) 127
Earth Roads, Engineering Supervision....(43) 155
Earth Roads, Kane County, Ill....(28) 140
Earth Roads, Location....(65) 243
Economic Problems, Popular Vote..(49) 273
Electric Cable, Cost of....(99) 385
Electric Companies, Effect Economies in Delivering Bills....(51) 253
Electric Traction Railless, Comparative Economics of....(27) 123
Electric Vehicles, Costs of Operation....(11) 107
Electric Welding, Applied to Steel Ship Construction....(62) 308
Electric Welding, Experiments of Lloyd's Register....(26) 420
Electrical and Mechanical Cost Data, Handbook....(71) 337
Electrically Operating Sewage Pumping Stations....(62) 264
Electrically-Welded Barge, The First English....(22) 416
Electricity for Blasting, Precautions....(125) 577
Electricity, Development of, by Natural Steam Power....(28) 422
Electrolysis, Drainage System of Protection....(104) 470
Emergency Fleet Corporation Report on Electric Welding....(62) 308
Employment Manager....(4) 52
Employes School, Water Department....(28) 164
Enamel Painting of Street Cars..(30) 188
Engineer and Architect....(90) 496
Engineer, Definition of....(112) 516
Engineer, Definition....(112) 584
Engineer, Pay of....(73) 317
Engineer, Pay of....(63) 309
Engineer, Krom Definition....(91) 457
Engineer in Roadwork....(131) 535
Engineer Salesmen, Export Field..(99) 505
Engineer, Structural, Definition...(109) 581
Engineer, Suggests for Mayor of Chicago....(114) 518
Engineer, At War....(21) 93
Engineering Council, Some of the Things It May Do....(26) 138
Engineering, British, French and American Leaders....(1) 97
Engineering Cost, County Road Work....(69) 328
Engineering Council Urges Conservation of Technical Engineers.(13) 85
Engineering, Management, Opportunities in....(94) 508
Engineering Periodicals, Relative Worth of....(3) 75
Engineering Profession and Its Younger Members....(29) 209
Engineering Society and American Association of Engineers....(25) 206
Engineering Societies, Cleveland, Amends Constitution....(105) 391
Engineering Societies, Public Works Appropriations....(93) 427
Engineering Societies, Work for Soldiers....(90) 456
Engineering, Structural....(33) 427
Engineering, Structural Courses in.(99) 385
Engineering Students, Draft....(3) 75
Engineering Students and Draft....(26) 138
Engineering Supervision for Earth Roads....(43) 155
Engineering, Teaching by "Case Method"....(127) 557
Engineers and Advertising....(31) 229
Engineers vs. Architects on War Work....(902) 508
Engineers and Builders, Advertising by....(91) 377
Engineers, Change from Professional to Executive Occupations....(73) 317
Engineers, Classification Blank For.(67) 313
Engineers Creed....(109) 453
Engineers' License Laws....(118) 570
Engineers, Migration from Professional to Managerial Position....(73) 317
Engineers, Municipal, Salaries....(27) 163
Engineers, Narrow Mindedness of..(1) 73
Engineers, Number in America....(111) 563
Engineers, Railway, Wages....(85) 371
Engineers, Resident Report On....(57) 235
Engineers and Revisions of Public Utility Laws....(48) 272
Engineers, Revision of Public Utility Laws....(72) 338
Engineers, Salaries of in Private Practice....(27) 163
Engineers to Study After War Conditions....(67) 269
Engineers Technical, Conservation of....(13) 85
Engineers, Unionization of....(91) 377
Engineers in War....(65) 289
Equalizing Girder, Cableway Erection of Steelwork....(100) 386
Equipment, Construction, Rental Prices of....(99) 485
Erosion, Novel Method of Control..(73) 339
Essex Border, Municipalities, Intercepting Sewers....(122) 552
Excavating Machinery for stripping, English....(8) 402
Excavation for Halifax-Ocean Terminals Railway....(94) 480
Excavation Methods, Niagara Power Canal....(120) 572
Excess Condemnation for Public Improvements....(80) 324
Excess Lime Treatment for Aberdeen Waterworks....(4) 100
Expansion Bearings of 1,000 ft. Continuous Girder, Kettle Rapids Bridge....(104) 390
Expansion Coupling New....(68) 268
Expansion Joint Installer, Concrete Pavements....(133) 537
Explosives, Calculation for Blasting....(119) 571
Explosives, Precautions for Handling....(79) 365
Export Field, Opportunities for Engineers....(99) 505
Extensometer Tests of Flat-Slab Floor....(38) 218

F

Fabricated Ship, the First English.(37) 431
Factories, training women for work....(38) 432
Factories, Work of Women in....(35) 429
Factory Stairs....(103) 509
Falsework, Safe Construction of.(61) 285
Failure of Concrete Test Cubes, Causes....(117) 521
Fares, Increased for Street Railways....(49) 273
Farm Products and Motor Trucking....(32) 436
Federal Aid Road Projects Status.(20) 20
Federal Council and Road Work..(12) 12
Fence Posts, Putting Down Pile Driver....(56) 234
Ferris Type Hull, Speedy Framing....(106) 392
Field Samples, Collecting....(18) 18
Field Test Results of Hydrated Lime, Concrete Roads....(85) 329
Filing Clippings from Engineering Papers....(50) 252
Fill, Leveled with Horse Push Scraper....(60) 284
Fill, 60 ft. One Trestle....(64) 278
Filter Plant Operation, Minneapolis, Cost....(82) 348
Filter Plant, Providence, Operating Results....(99) 465
Filtering, Cost....(28) 164
Filters, Flow of Water in Wash Water Troughs....(65) 461
Filtration Plant, Operating Costs, Grand Rapids....(46) 182
Filtration, Slow Sand and Multiple....(27) 123
Filtration Plants, Bacterial Removal in....(80) 346
Fire Connection, Dual....(105) 471
Fire Service Connection for Industrial Plants....(105) 471
Flat Slab Construction Bridges...(31) 211
Flat-Slab Construction, Canadian Tests....(38) 218
Flat Top Culverts, Railway Practice....(105) 511
Floates for Finishing Concrete Roads....(100) 444
Floor, Asphalt Mastic For....(22) 94
Floor Construction, Reinforced Concrete Core Type....(12) 84
Floors, Flat-Slab Tests....(38) 218
Flushing, Cost of....(42) 155
Footings, Wedge-Shape Rein. Con. Design....(121) 593
Force Account Paving, St. Paul...(78) 322
Foreign Engineers and Contractors, Work of....(2) 396
Foremen, Rules For......(74) 360 (90) 505
Forms, Concrete Building....(40) 136
Forms of Concrete Grain Bins, Construction....(101) 507
Form of Integral Curb....(41) 153
Forms, Working Models of, Buildings....(94) 289
Foundation, Bridge Pier Extending(13) 109
Foundation for Roads....(86) 330
Foundation for Street Car Track Paving....(13) 13
France, Mines and Countermines.(86) 372
France, Road Building....(15) 15
Frazil Ice, Methods of Handling...(85) 351
Freezing, Preventing in Riser Pipes....(99) 465
Freezing Process, Shaft Sinking..(32) 426
Frequency of Rainfall....(74) 340
Freight Deliveries Store Door....(33) 145
Freight, Handling, Philadelphia, Terminal....(105) 491
Freight Car, Reinforced Concrete.(26) 184
Friction Fenders, Troy Lock....(105) 491
Frost Penetration....(117) 547
Frozen Ground, Breaking Up....(4) 52
Frozen Ground, Depths....(117) 547
Frozen Ground, Thawing....(23) 95
Frozen Soil, Blasting Stumps....(106) 492
Furnace Slag for Pavement Foundation....(29) 423
Furness-Withy, Rein. Con. Cylinder Pier....(98) 484
Fuse, Improved Method of Igniting....(21) 69
Fuel Saving, and Metering....(89) 455
Fuel Saving by "Skip Stop Plan".(25) 182

G

Gage, Stilling Box, Irrigation for Canal Measurements....(113) 543
Garbage Collection, Cost, Cleveland....(129) 559
Garbage Collection and Disposal, American Cities....(114) 544
Garbage Collection of Motor Trucks....(68) 270
Garbage Disposal by Feeding to Hogs....(120) 550
Garbage Reduction, Cost....(124) 554
Garbage Reduction, Cost, Cleveland....(129) 559
Garbage Regulation, for Feeding Swine....(104) 470
Gardens, War....(2) 2
Gelatine, Efficiency of....(11) 107
General Contractors, National Association....(43) 201
Geology in Municipal Engineering.(36) 132
Germans, Research Work of....(27) 185
German Technical School, Attendance....(76) 362
Gold Mining Subsidized....(26) 206
Good Road, Measure of....(94) 428
Government Appropriation, Road Building....(111) 515
Government Classification Blank for Engineers....(67) 313
Government Clerks, Working Conditions and Pay of....(28) 186
Government Clerks, Working Hours....(2) 50
Government vs. Labor Union Regulation of Competition in Job Getting....(71) 315
Government, Mptor Truck Routes....(123) 527
Government Officials, Criticism of.(48) 294
Government Operation of Railways....(53) 277
Government Operation of Railways Five-Year Test....(111) 583
Government Price Regulation, Single Tax Theory....(71) 357
Grades Roads....(70) 248
Grading, Logging Railroad....(10) 58
Grading Street, Tractor Scraper Outfit....(5) 5
Grain Bins, Concrete, Construction with Steel Forms....(101) 507

Granite Block Paving for Street Car Tracks ....(8) 8
Gravel Plant, Washing and Screening ....(103) 447
Gravel Road Construction, Colorado ....(40) 125
Gravel Roads, Heavy Traffic, Continuous Dragging....(74) 318
Gravel Roads, Iowa Methods....(69) 247
Gravel Screens, Comparative Analysis of ....(14) 62
Gravel Tar Treatment of....(45) 157
Greenock Yards, Steel Ship Construction ....(32) 426
Grillage Beams, Bending Moments ....(113) 585
Grouting Pressure Contraction Joints of Arch Dams....(12) 36
Grout Pavement Sand....(3) 3
Guide Posts, Concrete Wayne County ....(104) 448
Gunite, Compressive Strength and Modulus of Electricity....(119) 591

H

Hand and Machine Tamping, Ties.(73) 359
Handbook, Mechanical and Electrical Cost Data....(71) 337
Harbor Work, Reinforced Concrete Piles in....(97) 483
Hauling, Cost of Teams....(120) 524
Hauling, Tractive Resistance On..(16) 16
Halifax Ocean Terminals Railway, Drilling and Blasting for....(94) 480
Halifax, Quay Wall....(103) 489
Head, Loss in Service Pipes....(56) 258
Heat Transmission....(7) 79
Heat Values of Wood....(28) 186
Hell Gate Arch Bridges, Rivets and Riveting ....(108) 194
Hetch Hetchy Water Supply Status ....(126) 556
High Pressure Mains, Leakage from ....(54) 256
Highway Bridge Design, Standardization of Detail....(107) 513
Highway Construction, Employment of Women....(79) 323
Highway Construction, Unwise Curtailment ....(92) 436
Highway Contract, New Form....(29) 187
Highway Contract, Outagamie County, Wis....(38) 150
Highway Contracts, Profit....(38) 150
Highway Contracts, Virginia....(53) 231
Highway County, Cost Keeping...(33) 145
Highway Cost Keeping....(109) 453
Highway Curves, Superelevation.(58) 236
Highway Design Notes........(4) 4, (59) 237, (83) 327
Highway Design, Preliminary Investigation ....(59) 237
Highway, Snow Removal....(93) 437
Highway Transport Committee, Snow Removal Program....(133) 537
Highway, Transport Committee, Work Developing Use of Road....(61) 239
Highway, After the War....(128) 532
Highways, Increased Tonnage Moved Over ....(77) 321
Highways, Motor Truck Parcel Post Service ....(23) 23
Highway Numbering, Clock System ....(36) 148
Highways, Relation to Motor Transport Efficiency....(119) 523
Highways, Trunk Line, Snow Removal ....(116) 520
Hogs, Feeding Garbage to....(120) 550
Hospital, Spanish Influenza....(103) 389
Hot Water Outfit for Thawing...(28) 164
Hot Water Supply Pipe, Eliminating Corrosion ....(51) 297
Houses, Pre-Cast Concrete....(34) 214
Housing, Industrial Dundee....(24) 120
Housing Project, English....(119) 591
Howden Dams....(2) 396
Hydrants, Thawing....(33) 169
Hydrants, Thawing Portable Steam Outfit ....(14) 38
Hydrated Lime in Concrete Road Construction ....(85) 329
Hydraulic Fill Construction Steam Jet Outfits for....(45) 181
Hydraulic Stripping, Quarrying...(112) 564
Hydro-Electric Developments, Lake Coleridge, New Zealand....(16) 112
Hydro-Electric Developments, Legislation ....(47) 249
Hydro-Electric Plants, Methods of Handling Frazil Ice....(85) 351
Hydro Electric Project, Lake Margaret ....(30) 126
Hydrogen Sulphide Water, Improvement by Aeration....(101) 467

I

Ice, Frazil, Handling....(85) 351
Ice Gorge, Method of Blasting....(59) 283
Ice, Removing From Car Tracks...(5) 5
Igniting Fuse, Improved Method of ....(21) 69
Imhoff Tanks, Rules for Operation.(6) 30
Industrial Developments, Individual Initiative in....(111) 563
Industrial Houses, Pre-Cast Concrete ....(34) 214
Industrial Housing, Dundee ....(24) 120
Industrial Housing Standards....(128) 600
Industrial Readjustment of American Industries ....(114) 566
Industrial Research, British....(29) 423
Industrial Research ....(17) 89
Industrial Survey, for Small Municipalities ....(64) 242
Industrial Trucks, Tractive Resistance of ....(27) 139
Industries After War....(7) 401
Industries, Standardized....(49) 273
Influenza Cases and Effect of Masking, San Francisco....(112) 542
Influenza Disseminated by Street Dust ....(91) 435
Influenza Masks, Fallacious Arguments Against ....(90) 476
Influenza, Prevention of....(111) 583
Influenza Masks, San Francisco..(112) 542
Inlet, Storm Sewer....(21) 21
Institution of Civil Engineers, Life and Work ....(23) 417
Instructions for Sewage Plants Operation ....(118) 547
Integral Curb, Form for....(41) 153
Intensity of Rainfall....(74) 340
Intercepting Sewers, Regulating Chambers for....(122) 552
International Joint Comm. on Pollution of Boundary Waters, Findings of ....(93) 459
Invention, British, French and American ....(1) 97
Inventions for War Purposes....(2) 161
Iron, Cleaning with Sand Blast..(113) 585
Iron Ore Mines, Overburden Stripping ....(8) 402
Iron Ore Mining with Electric Shovel ....(100) 486
Iron Painting ....(34) 130
Iron and Steel, Causes of Corrosion ....(127) 595
Iron and Steel, New Method of Testing ....(89) 495
Iron Work, Corrosion, Prevention.(40) 434
Irrigating, Vegetables with Sewage ....(68) 270
Irrigation, Border Method of....(34) 170
Irrigation Canals, Control of Algae ....(128) 559
Irrigation, Canal Measurements with Gage and Box....(113) 543
Irrigation, Methods of Measuring Water Deliveries....(97) 463
Irrigation, Mississippi Valley Land ....(2) 26
Irrigation Project Lindsay-Strathmore ....(17) 41
Irrigation Pumping, Arkansas River Valley ....(5) 29
Irrigation Pumping, Cost....(104) 470
Irrigation Pumping Plan....(92) 458
Irrigation, Sewage, Principles of.(12) 406
Irrigation Water Deliveries, Measuring ....(97) 463
Irrigation, West Side District Calif. ....(42) 178

J

Job Getting, Government vs. Labor Union Regulation of....(71) 315
Joint Installer, Expansion....(133) 537
Joints, Pipe Connections....(50) 252
Joints, Sewer Pipe Methods....(44) 180

K

Kansas, Irrigation Pumping....(5) 29
Kettle Rapids Bridge, Erection Steelwork ....(100) 386
Kettle Rapids Bridge, Expansion Bearings for ....(104) 390
King County, Washing and Screening Plan ....(103) 447
Krom, Definition of Engineer....(91) 457

L

Laboratory for Industrial Research, British ....(29) 423
Labor, Materials New York Road Work ....(46) 158
Labor Saving Appliances, Rail Renewing ....(77) 363
Labor Saving Machinery in Water Works Service....(4) 28
Labor Union and Draftsmen....(49) 227
Labor Union, Opposition of Women Workers ....(69) 335
Labor Women, Factories....(35) 429
Labor, Women Heavy Construction ....(36) 430
Labor, Women in Munition Factories ....(38) 432
Ladder Dredgers, Economies of....(5) 101
Ladders, Government Lock, Troy.(105) 491
Lake Coleridge, New Zealand, Hydro-Electric Developments....(16) 112
Lake Margaret, Hydro-Electric Project ....(30) 126
Land Clearing, Stump Pulling Tool ....(115) 567
Land Reclamation, Providing Work for Soldiers ....(118) 522
Land Reclamation, Pumping Stations in ....(13) 407
Land Reclamation Survey, $100,000 Appropriated For ....(48) 250
Langwies, Reinforced Concrete Viaduct ....(3) 99
Larderello, Italy, Natural Steam Power ....(28) 422
Laws, License to Engineers....(118) 570
Laws, Public Utilities, Revisions..(48) 272
Laws, Public Utility, Revision....(72) 358
Lead Pipe Connection for Water Services ....(50) 252
Leaks, Water Services....(50) 252
Leakage from High Pressure Mains ....(54) 256
Leakage from New Water Mains.(117) 547
Leakage from Water Mains Determined with Dionic Tester....(16) 40
Lecture Method of Teaching....(72) 316
Lecture Method of Teaching....(82) 326
Levee Construction for Drainage Districts ....(86) 352
Levee Construction, North Texas.(17) 65
Levee Construction, Power Driven Machinery ....(7) 55
Levee Settlement, Cause....(35) 193
Libraries, Public Use of....(2) 2
Life, Economic Office Building....(37) 217
Lime, Correcting Acidity in Sludge.(96) 462
Lime Mortars, Setting Process....(13) 407
Limestone Quarrying, Methods and Machines ....(92) 478
Lindsay-Strathmore Irrigation Project ....(17) 41
Line Hooks, Government Lock, Troy ....(105) 491
Liquid War Paint....(108) 514
Load Factor, Street Car Service...(48) 272
Loader, Self-Feeding Bucket for Handling Crushed Rock....(128) 532
Location Methods for Water Works Distribution System ....(35) 171
Lock Wall Construction with Small Derricks ....(40) 198
Locomotive, Gas Driven, for Industrial Purposes ....(84) 370
Logan Waller Page....(125) 577
Logging Railroad, Grading for....(10) 58
London Water Supply, Algae Growths and Chlorine Treatment....(20) 414
London, Sewage Disposal....(35) 429
Lubricant to Wire Rope....(61) 285
Lumber, Salvaging with Resawing Plant ....(11) 83
Lumber, Structural Merits of....(47) 293
Luting Method of Obtaining Pavement Contour ....(62) 240

M

Macadam, Bituminous Surfaces on.(37) 149
Macadam, Excessive Crown on....(32) 144
Macadam, Cost of, Hamilton, Ont..(65) 243
Macadam, Internal Wear....(3) 3
Macadam, Repairing Roads....(108) 452
Macadam, Resurfacing with Loam Filler Gravel ....(82) 326
Macadam, Rolling, Cost....(70) 248
Macadam, Shaping Up, Cost of....(70) 248
Macadam Streets, Oiling....(17) 17
Macadam, Tar Treatment....(45) 157
Madras Harbor, Quay....(40) 434
Mains, High Pressure, Leakage..(54) 256
Make Your Knowledge Militant....(69) 355
Malarial Control Campaign....(78) 344
Malaria, Prevention Work at Camp Bowie, Tex....(58) 260
Malaria Prevention by St. Louis Southwestern Ry....(44) 202
Management, Engineering Field, Opportunities ....(94) 500
Manganese and Open Hearth Rail, Life on Curves ....(93) 479
Map, Bridge and Drainage....(41) 221
Marine Structures, Precautions for Using Rein. Con....(106) 492
Marine Works, Reinforced Concrete in ....(97) 483
Marking Government Corners with Charcoal ....(113) 565
Masks, Influenza (Fallacious Arguments Against) ....(90) 476
Masonry, Brick, Breaking Up....(106) 512
Masonry, Old Stone, Repairing..(104) 390
Masonry Viaduct 89 Years Old...(102) 388
Massachusetts "Cost Plus Profit" Road Contract ....(14) 14
Mast Turning Lathe....(98) 384
Materials, New York Road Work..(46) 158
Measure of a Good Road....(94) 438
Measuring Chambers for Intercepting Sewers ....(122) 552
Measuring, Irrigation Water Deliveries ....(97) 463
Mechanical and Electrical Cost Data, Handbook ....(71) 337
Mechanical Lift Bridges, Mechanical Features ....(95) 501
Medical Profession, Drafting....(26) 162
Medlow Dam, New South Wales..(17) 113
Menai Suspension Bridge, Tests on Tie Bars ....(39) 433
Merchant Ships, Joint Ownership of ....(90) 376
Mesabi Range, Stripping Equipment ....(18) 66
Metal-Cutting Manufacture in Use of Oxygen ....(23) 129
Metalium for Pipe Joints....(82) 348
Meter Installation, Cost at Chicago.(51) 253
Meter Readers, Post Cards....(68) 270
Meter Repairs, Cost of Chicago....(57) 259
Metering, Arguments for....(59) 261

Metering, Compulsory for Fuel Saving ....(89) 455
Meters, Cost of Installing..........(8) 32
Meters, Water, Chicago, City Engineer's Recommendations ..........(109) 539
Microphotographs, Growths in Water ....(12) 406
Miles Acid Process, Deoxygenating Effect of the Effluent..........(30) 166
Milk, Distributed by Public Service Companies ..........(90) 496
Mill Buildings, Wood..........(45) 225
Miller System of Ship Framing....(38) 432
Mines and Countermines on French Front ..........(86) 372
Mining Gold, Subsidizing..........(26) 206
Mining, Underground, Electric Shovel ....(100) 486
Minneapolis, Water Purification Plant ....(81) 347
Mississippi Valley Land Drainage.(2) 26
Mixer, Cement Bag Holder for....(131) 535
Modulus Elasticity, Gunite........(119) 591
Monolithic Brick Pavement, Cost..(68) 246
Mortars, Proportioning by Surface Areas of Aggregates.........(59) 305
Mosquito Control, Methods of.....(58) 260
Mosquitoes, Methods of Eradicating ....(78) 344
Motor Apparatus at Street Cleaning ....(100) 445
Motor Cars in United States.......(18) 18
Motor Convoy Routes, Snow Removal ....(104) 448
Motor Sweeping, Costs..........(36) 132
Motor Traffic, Pavement Layouts Inadequate ..........(114) 518
Motor Transport Efficiency of Highways ..........(119) 523
Motor Truck Operation, Cost Keeping System ..........(42) 154
Motor Truck Routes, Government.(123) 527
Motor Truck Competition, Railway Operation ..........(70) 356
Motor Truck, Parcel Post Service on Highways ..........(23) 23
Motor Trucking and Farm Production ....(92) 436
Motor Ash Trucks, Working Costs.(7) 103
Motor Trucks, Operating Cost.......
...(11) 407, (14) 110, (48) 160, (68) 270
Motor Trucks, Garbage Collection.(68) 270
Multiple Arch, Reinforced Concrete Dam ..........(29) 165
Multiplex Telephony ..........(110) 582
Municipal Engineering, Applied Geology in ..........(36) 132
Municipal Engineers, Salaries of Chicago ..........(51) 229
Municipal Improvements, Policies Formulated by Engineers........(3) 27
Municipal Printed Matter, Waste..(27) 139
Municipal Salvage of Refuse, Possibilities ..........(10) 404
Munition Factories, Employment of Women in ..........(39) 135
Murrumbidgee Irrigation Project, 236 ft. Dam ..........(10) 106
Mystic River Bridge, Pier Construction of ..........(102) 508

N

National Association of General Contractors ..........(43) 201
National Association of General Contractors, Constitution for....(102) 388
National Laboratory for Industrial Research ..........(29) 423
National Wants, Effect of War on.(1) 395
Natural Steam Power Plant........(28) 422
Navy Yards, Cost of Warehouses at ....(44) 224
New Building Work, State Councils of Defence ..........(61) 307
New England Water Works Association, Report on Thawing Water Mains ..........(121) 551
New York, State Highway Construction in 1917..........(127) 531
New Zealand, Drainage Operations in ....(21) 127
Niagara Power Canal, Excavation Methods ..........(120) 572
Nidus, Clinker vs. Gravel.........(5) 105

O

Office Buildings, Depreciation of..(116) 588
Office Buildings, Design of........(40) 220
Office Buildings, Economic Life of.(37) 217
Officials, Government, Criticisms..(48) 294
Offsets, Superelevations, Table of..(58) 236
Oiling, Macadam Streets..........(17) 17
Open Hearth Rail, Manganese on Curves ..........(93) 479
Ore Dock, N. P. Ry. Extension, Superior ..........(4) 52
Oregon Society of Engineers, Aims.(50) 252

P

Paint, Considerations in Selection of ....(126) 598
Paint, Liquid Wax..........(108) 514
Paint, Selecting an Economic......(36) 216
Painting, Cost, Steel Highway Bridge ....(110) 454
Painting, Enamel Street Cars.....(30) 188
Painting, Iron and Steel..........(34) 130
Paints and Prevention of Iron Corrosion ..........(40) 434
Panorama, Reinforced Concrete...(34) 130
Paper, Government Waste of......(5L) 229
Parcel Post Service on Highways.(23) 23
Park System, Maintenance Cost...(121) 525
Partitions, Design and Construction of ....(42) 222
Patrolmen Road, Report Forms for.(19) 19
Patrolmen, Road Suggestions for.(58) 236
Patrol System, Street Cleaning, St. Paul ..........(68) 246
Pavement Arch Action of..........(3) 3
Pavement, Asphalt, Maintenance Cost ....(104) 448
Pavement, Asphalt, Rainy Weather Construction ..........(124) 528
Pavement, Asphalt, Repairing, Buffalo ....(102) 446
Pavement, Bituminous Concrete Mixer Construction ..........(6) 6
Pavement, Brick, Organization Gang for Laying ..........(57) 245
Pavement, Concrete, Circumferential Rods ..........(102) 446
Pavement Contour, Obtained Without Use of Strikeboard..........(62) 240
Pavement Cuts with Pneumatic Drills ....(10) 450
Pavement, Financing ..........(107) 451
Pavement Foundation, Furnace Slag for ..........(29) 423
Pavement Grout, Fine Sand for...(3) 3
Pavement Layouts Inadequate, Motor Traffic ..........(114) 518
Pavement Planer Method of Finishing Concrete Roads ..........(74) 318
Pavement Slabs, Method of Raising ....(105) 449
Pavement Structure, Design of.....(4) 4
Pavement, Widening for Motor Traffic ....(114) 518
Pavements, Asphalt, Construction..(9) 9
Pavements, Asphalt, Design........(9) 9
Pavements, Bituminous Concrete Bases for ..........(96) 440
Pavements, Bituminous, Recent Practice in ..........(30) 142
Pavements, Concrete Base, Gang Constructing ..........(126) 530
Pavements, Concrete, Vertical Movements in ..........(97) 441
Pavements, Reinforced Concrete Base ....(7) 103
Pavements, Tile Foundation......(105) 449
Pavements, Underdrainage ........(38) 150
Pavements, Wood Block Creosoted..(7) 7
Pavements, Wornout, Resurfacing with Concrete ..........(21) 21
Paving Brick, Industrial Uses......(3) 75
Paving, Force Account, St. Paul, Minn. ..........(78) 322
Paving Gang for Concrete........(76) 320
Paving, Granite Blocks, Street Car Tracks ..........(8) 8
Paving River Banks..........(54) 278
Paving Street Car Tracks at Toronto ....(13) 13
Paving, Street, Underground Study.(47) 159
Paving, Who Sall Pay for..........
.......... (107) 451, (113) 517
Peak Load of Street Railways, Reducing ..........(48) 272
Penstock, Economic Design for...(124) 554
Penstock Pipe Design, Economic Pressure Pipe for..........(124) 554
Periodicals, Engineering, Relative Worth of ..........(3) 75
Philadelphia, Street Cleaning.....(127) 531
Philadelphia Terminals, New System of Handling Freight ..........(105) 491
Picaroon Axe from Old Axe........(60) 284
Piers, Brick, Large, Strength....(106) 512
Pier Foundations, Method of Extending ....(13) 109
Pier, Furness-Withy, Concrete.....(98) 484
Pier, Mystic River Bridge Construction ....(102) 508
Piers, Reinforced Concrete.........(97) 483
Pile Bearing Formulas..........(36) 194
Pile Concrete, Saving of Steel......(5) 77
Pile Driving Method..........(15) 111
Pile Driving, World's Record.......(10) 58
Piles, Reinforced Concrete in Harbor Work ..........(97) 483
Piles, Supporting Power..........(15) 111
Piles, Supporting Power of........(36) 194
Pipe Joints, Making in Wet Trench ....(68) 270
Pipe Joints, Use of Metalium for..(82) 348
Pipe Tripod, Portable..........(33) 169
Pipes, Cast Iron, Specifications....(36) 430
Pitometer Survey at Ottawa......(32) 168
Planer, Power-Operated..........(23) 95
Planning, City ..........(64) 242
Plant Extensions of Public Utilities.(8) 32
Plants, Rental Prices ..........(99) 485
Plasters, Settling Action of.......(8) 80
Plumbing Fixtures, Rates of Use of Water by ..........(126) 556
Pneumatic Caisson Method of Quay Wall Construction, Halifax..(103) 489
Pneumatic Machine for Bending Cold Plates ..........(53) 299
Pneumatic Punching Device for Drill Steel ..........(24) 72
Pneumatic Riveting, British Shipyards ....(10) 404
Pneumatic Tie Tampers for Loosening Frozen Coal ..........(11) 59
Pneumatic Tie Tampers Widening Rock Cut ..........(39) 197
Pneumatic, Tie Tamping..........(73) 359
Pneumatic Tools, Filtered Air Supply for ..........(84) 370
Pneumatic Tools, Separator for...(87) 373
Pole Holes, Digging with Dynamite ....(60) 284
Pontoon Drawbridge, Operates on River Kite Principle ..........(50) 296
Poole Harbor, England Shipyard.(115) 587
Popular Vote, Economic Problems.(49) 273
Portland Cement Association, New General Manager ..........(130) 560
Portland Cement, Setting Process.(13) 407
Portable Conveyors, Uses of.......(83) 369
Postal Card, Water Bill..........(128) 558
Post Cards, Meter Readers.........(68) 270
Post-War Improvements, Buffalo Plan ....(105) 449
Post-War Reconstruction Arrangements ..........(9) 403
Power Driven Machinery of Levee Construction ..........(7) 55
Power Plant, Practical Rules for Burning Coal ..........(105) 471
Pre-Cast Beams, Facing 52-Ton..(14) 86
Precast Concrete Piles for Driving. 299
President Wilson and Railway Problem ....(122) 574
President Wilson and Government Ownership ..........(110) 562
Pressure Pipe on Penstock Design.(124) 554
Price Regulation, Taxation of Profits as a Factor in..........(72) 316
Priorities Division, Regulations for New War Construction ..........(68) 314
Priority Orders, Public Utilities....(84) 350
Production Control in Shipbuilding.(91) 497
Profits, Taxation of as a Factor in Price Regulation ..........(72) 316
Proportioning Mortars by Surface Areas ....(59) 305
Proposal Advertisements, Art of Writing ..........(73) 317
Public Unfair ..........(27) 139
Public Improvements, Excess Condemnation for ..........(80) 324
Public Utility Companies, Large, Often Poorly Managed ..........(75) 56
Public Utility Laws, Revisions of..(48) 272
Public Utility Laws, Revision by Engineers ..........(72) 338
Public Utilities, How Priority Orders May Be Obtained..........(85) 350
Public Utilities, Plant Extensions of ....(8) 32
Public Service Commissions........(47) 271
Public Service Commissions and Standardized Industry ..........(71) 357
Public Works Appropriation, Engineering Societies ..........(93) 437
Public Works Bonds, Capital Issues Committee ..........(91) 497
Public Works, Great Appropriations for ....(89) 475
Public Works and Readjustment Period ....(109) 561
Pump, Irrigation Geared to Automobile Engine ..........(107) 473
Pump, Recovering from Deep Well.(64) 266
Pumping, Cost of, Louisville, Ky..(9) 33
Pumping Experiments, Subsoil Water Supply ..........(31) 425
Pumping Plant, Community Irrigation ....(92) 458
Pumping, Irrigation, Arkansas Valley ....(5) 29
Pumping, Irrigation, Cost, Chandler District ..........(104) 470
Pumping Station, Small Automatic, for Sewage ..........(45) 181
Pumping Stations, Land Reclamation, Holland ..........(13) 407
Pumping Stations, Waterloo, Ia...(62) 264

Q

Quantity Surveys for Buildings...(101) 507
Quarries, Well Drilling Method of Blasting at ..........(52) 276
Quarry Blasting, with Electricity Precautions ..........(125) 577
Quarry Operation, Accident Prevention in ..........(11) 59
Quarry Stripping, Conveyor and Steam Shovel ..........(113) 565
Quarry Transportation, One Man Cars for ..........(52) 276
Quarrying, Hydraulic Stripping in.(112) 564
Quarrying, Labor-Saving Methods and Machines ..........(92) 478
Quay, Madras Harbor ..........(40) 434
Quay Wall Construction, Halifax.(103) 489

R

Radiation ..........(7) 79
Rail-Creep .... (23) 119, (72) 358, (112) 564
Rails, Drilling Machine for.......(77) 363
Rail Handling Machine..........(77) 363
Rail Renewing, Labor Saving Appliances for ..........(77) 363
Rails, Loading with Ditcher Cost..(72) 358
Rails, Ties, Street Railway Track.(82) 368
Railroad Problems, Today's.......(123) 575
Railroads, Logging, Grading.......(10) 58

Railroads, Russian (8) 56
Railroads, Seven Months' Operation by Government (53) 277
Railway Bridge, Flat Slab, First (32) 212
Railway Bridges, Methods of Strengthening (125) 597
Railway Bridges, Old, Investigating (122) 594
Railway Construction in Africa (38) 144
Railway Construction, Federal Allotments for (23) 71
Railway Ditching (76) 362
Railway Engineers, Wages of (85) 371
Railway, Halifax, Ocean Terminals of (94) 480
Railway Improvement, Providing for Returned Soldiers (118) 522
Railway Labor, U. S. Employment Service (78) 364
Railway Operation and Motor Truck Competition (70) 356
Railway Practice, Design of Concrete Floor Slabs (105) 511
Railway Practice in Design (105) 511
Railway Problem, President Wilson (122) 574
Railway Rolling Stock, Henry Ford's Criticism (26) 184
Railway Tracks, Machine for Removing (116) 568
Railway Track, Reinforced Concrete Ties for (25) 419
Railways, British, War Control (6) 400
Railways, Concrete Roadbed for (111) 563
Railways, Government Operation, Five-Year Test (111) 583
Railways, Government Ownership of (110) 562
Railways, Lack of in China (2) 50
Railways, Trans-Australian, Construction Features (19) 413
Rainfall Average for 50 Years (8) 32
Rainfall, Relation Between Frequency and Intensity (74) 340
Rangoon Training Wall (23) 119
Rapid Sand Filters, Wash Water Troughs (95) 461
Rapid Sand Filtration Plants and Law of Bacterial Removal (80) 346
Rates, Readjustment of Water Rates (86) 352
Rates, Water, Raising (117) 547
Rates, Water, Inadequate (26) 162
Rates, Water, St. Louis (11) 35
Readjustment Period and Public Works (109) 561
Reconstruction Arrangements, Post-War (9) 403
Reconstruction, Building Industry (116) 568
Refuse Destructor Clinker in Road Work (32) 426
Refuse, Municipal Salvage of (10) 404
Registration Blanks, Technical Men (67) 313
Regulating and Measuring Chambers for Intercepting Sewers (122) 552
Reinforced Concrete Bridges, Pre-Cast Members (12) 108
Reinforced Concrete Cribs (98) 484
Reinforced Concrete Floor Construction, Core Type (12) 84
Reinforced Concrete, Hollow Block Wall (98) 474
Rein. Con. Marine Structures (106) 492
Reinforced Concrete, Marine Works (96) 483
Reinforced Concrete Panorama (34) 130
Reinforced Concrete Slab, Full Size Tests (93) 499
Reinforced Concrete Ships, Design and Construction (15) 409
Reinforced Concrete Ships, English (115) 587
Reinforced Concrete Ships (24) 418
Reinforced Concrete, Theatre des Champs Elysees (32) 128
Rein. Con. Tower and Tank (59) 261
Reinforced Concrete Track for Testing Motor Trucks (126) 530
Reinforcement for Concrete Roads (39) 151
Reinsch-Wurl Screens, Operating Results (107) 473
Rental Prices, Construction Plant (99) 485
Rental Rates for Road Equipment (93) 437
Report Forms, Patrolmen (19) 19
Report for Resident Engineers on Road Work (57) 275
Resawing Plant, Salvaging Lumber with (11) 83
Research Industrial (17) 89
Research, Industrial, British (29) 423
Research Work of Germans (27) 185
Reservoir, Device Indicating Water Level in (66) 268
Resident Engineers, Report Form for (57) 235
Respiratory, Diseases and Street Flushing (51) 229
Resurfacing Old Concrete Roads (132) 536
Resurfacing Wornout Pavements with Concrete (21) 21
Retaining Walls, Reinforced Concrete (97) 483
Revetment, Gravity Plant for Paving, Concrete River Banks (54) 278
Riser Pipes, Preventing Freezing in (96) 465
River Kite Drawbridge (50) 296
Rivet and Riveting, Hell Gate Arch Bridge (108) 394
Rivetless Ship Building, English (22) 416
Roadbed, Concrete, on Northern Pacific (7) 55
Roadbed, Concrete, Railways (111) 563
Road Building and Federal Appropriation (111) 515
Road Building at the Front (15) 15
Road Building, War Time Policy (16) 16
Road Construction, Hauling Materials with Dinkies (55) 233
Road Construction with Mechanical System for Handling Material (55) 232
Road Construction, Steam Shovel Work (102) 446
Road Contract Based on Efficiency and Speed Factor (49) 228
Road Contract—Cost Plus (2) 2
Road Contract, Cost Plus, Massachusetts (14) 14
Road Contracting, Hazards of (51) 229
Road Grades, Maximum (70) 248
Road Dragging, Trucks and Tractors (19) 19
Road Equipment, Rental Rates (93) 437
Road Machine and Tractor (18) 18
Road Maintenance, Concrete, Wayne County (115) 519
Road Maintenance, Connecticut (16) 16
Road Maintenance Costs, Washington (125) 529
Road Maintenance, Township, Illinois (14) 14
Road Mileage, U. S (79) 323
Road Oil Curing Concrete Roads (108) 452
Road Patrolmen, Suggestions for (38) 236
Road Patrolmen, Wisconsin, Report (19) 19
Road, Pneumatic Machinery and Labor Saving Devices (106) 450
Roads, Maintenance Costs (125) 529
Road Repairs, Connecticut (16) 16
Road Roller Wheels, Oiling (53) 231
Road Sprinkling, State Highway Department (75) 319
Road Surfaces, Tarring Practice (30) 142
Roadside Trees, Reserving and Planting (89) 333
Road Wear, Measuring (22) 22
Road Work Controlled by Federal Council (12) 12
Road Work, Kentucky, Disqualification of Bidders (29) 141
Road Work, Engineer in (131) 535
Road Work, Refuse Destructor for (32) 425
Road Work, U. S., 1917 (46) 158
Roads, Concrete Construction Freezing Temperature (35) 147
Roads, Concrete, Cracking (39) 151
Roads, Concrete, Curing (108) 452
Roads, Concrete, Finishing Method (100) 444
Roads, Concrete, Wayne County (107) 451
Roads, County, Iowa, Cost (68) 246
Roads, Earth, Engineering Supervision (43) 155
Roads, Earth, Kane County (28) 140
Roads, Earth, Location (65) 243
Roads, Federal Aid Status (20) 20
Roads, Foundation for Heavy Traffic (86) 330
Roads, Gravel, Colorado (40) 152
Roads, Gravel, Iowa, Methods of (69) 247
Roads, Inadequate Funds for (1) 1
Roads, Lack of in China (2) 50
Roads, Lessons of War (39) 433
Roads, Spring Breakup, New York (129) 533
Roads, Tractive Tests on (3) 3
Roads, Vermilion County, Effect of War (85) 329
Rock, Abrasion Tests (5) 5
Rock Crusher, Standardization of Sizes (129) 533
Rock Crushing, Standardization of Screen for (88) 332
Rock Cut Widening with Pneumatic Tie Tampers (39) 197
Rock Drill, Accessory Equipment, Efficiency Tests (81) 367
Rock Drill Efficiency, Air Transmission (82) 368
Rods, Circumferential, for Concrete Pavement Rein. (102) 446
Roller Belt Method, Concrete Road (86) 330
Rope, Selecting and Protecting (80) 366
Rope, Wire, Lubrication of (61) 285
Ropeway Bicable (35) 131
Rubbish Collection, American Cities (114) 544
Rural Communities, Water Supplies (52) 254
Russian Railroads, the American Railway Comm. (8) 56

S

Safety Engineering Construction Work (40) 198
Safety Engineering (53) 299
St. Paul Engineering Society, War Work (107) 513
Sahara Desert, French Developments (17) 113
Salesmen Engineer, Export Field (99) 505
Salvage Department at Shipyards (103) 389
Sampling, Boulder Deposits (8) 8
Sampling Sewage (15) 11
Sand Blast Cleaning Iron (113) 585
Sand Filters vs. Coagulants, Water Purification (5) 399
Sand Drag Train Stop (37) 431
Sand, Handled with Air Lift (36) 194
Sand Pump for Handling Screenings (24) 72
Sand, Spreading Device for (119) 523
Sand Spreader, San Francisco (11) 523
Sanitation Camp (38) 134
Sanitation, Construction Camps (50) 274
Scaffolds, Accidents in Connection (61) 285
Scaffolds, Painters' Suspended (63) 287
Science and War (49) 295
Scraper, Street Cleaning (38) 150
Screen Opening, Standardization of (88) 332
Screenings Handled with Air Lift (36) 194
Screenings, Mechanical Spreader for (82) 326
Screening, Handling with Sand-Pump (24) 72
Screens, Gravel, Comparative Analysis of (14) 62
Screens, Reinsch-Wurl, Operating Results (107) 473
Sedalia, Mo., Sewage Treatment (10) 34
Seneca Mine, Sinking Shaft at (86) 482
Separator, Removing Water from Compressed Air (87) 373
Service Connections to Concrete Water Mains (103) 469
Service Pipes, Loss of Head in (56) 258
Services, Thawing with Hot Water (28) 164
Services, Cost of Installing, Louisville (19) 43
Services, Thawing with Electricity (21) 45
Setting Process in Lime Mortars and Portland Cement (13) 407
Sewage Condemns, Irrigating Vegetables (68) 270
Sewage Disposal, Experiments, Croydon (19) 413
Sewage Disposal, London (35) 429
Sewage Disposal, Operating Results, Rochester (107) 473
Sewage Disposal, Operation of Imhoff Tanks (6) 30
Sewage Disposal Works, Control of (106) 472
Sewage Irrigation, Principles of (12) 406
Sewage Lifting System, Compressed Air, Cairo (18) 114
Sewage, Methods of Sampling (15) 11
Sewage Plants, Instruction for Operation (118) 548
Sewage Pumping Stations, Waterloo (62) 264
Sewage Pumping Station, Small Automatic (45) 181
Sewage Treatment Plants, Design and Operation (55) 257
Sewage Treatment, Miles Acid Process (40) 166
Sewage Treatment Plants, Operating Rules for (39) 175
Sewage Treatment, Sedalia, Mo. (10) 34
Sewage Treatment, Tentative Standards for (64) 266
Sewage Work, Control, English Practice (106) 472
Sewer, Brick, Labor Cost of (65) 267
Sewer Construction, Cost, Providence (104) 470
Sewer Pipe Joints, Methods (21) 45
Sewer Pipe Joints, Methods (44) 180
Sewer Pipe, Methods of Making (21) 45
Sewer Storm Inlet (21) 21
Sewers, Combined or Separate, Selections of (57) 259
Sewers, Intercepting, Regulating Chambers for (122) 522
Shaft Sinking, Employment of Divers (19) 67
Shaft Sinking by Freezing Process (32) 326
Shaft Sinking, Seneca Mine (96) 482
Sheet Piles, Reinforced Concrete (97) 483
Shipbuilding, American, During War (97) 503
Ship Building, Danger in Too Much (49) 295
Shipbuilding, Electric Welding in (26) 420
Shipbuilding Industry in the Future in America (26) 206
Shipbuilding, Production Control (91) 497
Shipbuilding Progress in U. S. (93) 379
Ship Channels and Shipbuilding Bulb Angles (124) 596
Ship Construction with Light Weight Concrete (27) 207
Ship Fabricated, the First English (37) 431
Ship Framing, Millar System (38) 432
Ship Repairs by Cofferdam (127) 579
Ship Shapes, Standard (124) 596
Ship, Steel, Greenock Yards (32) 426
Ships, Concrete Construction Features (57) 303
Ships, Concrete, Design Features (16) 88
Ships, Concrete, Light Weight (42) 222
Ships, Instrument for Recording Strains (105) 391
Ships, Merchant, Joint Ownership of 90 376
Ships, Reinforced Concrete (24) 418
Ships, Reinforced Concrete, Design and Construction (15) 409
Ships, Rein. Con., English Yards (115) 587
Ships, Rivetless Steel (34) 214
Ships, Present and Prospective Shortage (110) 582
Ships, Wooden Repairing Concrete (112) 584

Shipyards, British, Pneumatic Riveting ([illegible]) [illegible]
Shipyards Organization Typical...(92) 498
Shipyards, Food [illegible] ([illegible]) [illegible]
Shipyard Salvage Department ([illegible]) [illegible]
Shop Floors, Asphalt Mastic ([illegible]) [illegible]
Skip Stop Plan and Fuel Economy ([illegible]) [illegible]
"Skip-Stop Plan, Street Car Service ........(50) 296
"Skip-Stop Plan" Street Railway..(25) 183
"Skip-Stop System," Street Railways ([illegible]) [illegible]
Shovels, Electric, Operating Cost ([illegible]) [illegible]
Shovel, Steam, Easily Portable ([illegible]) [illegible]
Single Tax Theory and Government Price Regulation ([illegible]) [illegible]
Slag for Pavement Base ([illegible]) [illegible]
Sleeve, Steel, for Repairing Water Mains (81) [illegible]
Slow Sand Filtration Plant Operating Results ([illegible]) [illegible]
Slow Sand and Multiple Filtration..(27) 123
Sludge, Acidity, Correcting with Lime ([illegible]) [illegible]
Sludge Depth, Measuring Deep Sedimentation Tanks (81) [illegible]
Sludge, Dewatering (100) [illegible]
Sludge Disposal, Providence......(107) 473
Sludge Removal, Cost of, Columbus.(21) 45
Sludge Ships for Sewage Disposal, London ([illegible]) 429
Smoke Stacks, Cleaning Soot from.(50) 274
Snow Removal, Clam Shell Bucket in (34) 192
Snow Removal, Connecticut Highways ([illegible]) [illegible]
Snow Removal, Connecticut Practice (116) 520
Snow Removal, Highways Transport Committee (130) [illegible]
Snow Removal from Highways, Pa. (116) 520
Snow Removal, Motor Convoy Routes (104) [illegible]
Snow Roads, Opening Up ([illegible]) [illegible]
Societies, Engineering, Public Works Appropriation (90) [illegible]
Societies, Engineering, for Soldiers.(90) 456
Socket Extractor, Air Drill (126) [illegible]
Soldiers, Engineering Societies to Provide Work for (90) 456
Soldiers, Returned, Providing for.(125) 529
Soldiers, Work for ................(118) 522
Sound Ranging, Locating Enemy Guns by ..........................(22) 22
Spanish Influenza Hospital........(103) 389
Specifications, English, for Cast Iron Pipes (36) 430
Specifications, Roller and Belt Method, Finishing Concrete Roads (86) [illegible]
Spontaneous Combustion of Waste.(22) 118
Spring Breakup of Roads in New York (129) [illegible]
Spruce by Airplanes..............(25) 206
Spruce Timbers, Strength of 100-Year Old .........................(38) 196
Squegee Work, Cost, St. Paul.....(68) 246
Staggering Business Hours, Reduce Peak Load of Railways......(48) 272
Stairs, Factory (103) [illegible]
Standard Sizes, Crushed Stone...(129) 533
Standard Ship Shapes (124) [illegible]
Standardized Industries (49) [illegible]
Standardized Industry (71) [illegible]
Standardization of Catalogs........(72) 338
Standardization of Detail, Highway Bridge Design (107) [illegible]
Standards, Industrial Housing....(128) 600
Standards of Purity, Water........(14) 38
Standards, Water Purity..........(104) 470
Standards of Quality for Water....(32) 168
Standards, Tentative for Sewage Treatment (64) [illegible]
Standpipes and Water Towers.....(68) 270
State Councils of Defense, New Building Work (61) [illegible]
State Highway, Construction, Employment of Women on..........(79) 323
State Highway Construction, New York in 1917 (127) 531
Station Work on Concrete Aqueduct (76) [illegible]
Steam Hopper Dredgers, Economics of ([illegible]) [illegible]
Steam Jet Outfits, Hydraulic Fill Construction ([illegible]) 181
Steam Motor Wagons, Cost of Operation (48) [illegible]
Steam Shovel Cuts Stripping on Mesabi Range (18) [illegible]
Steam Shovel in Road Construction ([illegible]) [illegible]
Steam Shovel, Trenching and Backfilling with.....................(129) 559
Steam Shovel Work, Blasting for..(55) 279
Steam Shovel Work Breaking Up Frozen Ground ([illegible]) [illegible]
Steam Shovel Work, Cost, in Road Construction ([illegible]) [illegible]
Steel Painting ([illegible]) [illegible]
Steel Ship Construction, [illegible] Yard [illegible]
Steel Ship Construction with Electric Welding ([illegible]) [illegible]
Steel, Temperature of, Exposed to Sun ([illegible]) [illegible]
Steel Vessel, Welded...............(34) 214
Steel Wharves, Corrosion of (18) [illegible]
[illegible]
Stilling Box, Irrigation for Canal Measurement ([illegible]) [illegible]
[illegible]
[illegible]
[illegible]
Storage of Water, Advantages and Disadvantages ([illegible]) [illegible]
[illegible]
Storm Sewer Inlet.................(21) 21
Strains, Instrument for Recording in Ship ([illegible]) [illegible]
[illegible]
[illegible]
[illegible]
[illegible]
Street Cars, Enamel Painting of...(30) 188
Street Car Service [illegible]
Street Car Service, Skip-Stop Plan.(50) 296
Street Cleaning and City Engineers(25) 137
Street Cleaning, Cost, St. Paul....(68) 245
Street Cleaning, [illegible]
Street Cleaning [illegible]
Street Cleaning with Motor Apparatus ([illegible]) [illegible]
Street Cleaning, Philadelphia 1917.(127) 531
Street Cleaning, Squeegee, St. Paul, Cost (68) [illegible]
Street Cleaning, Scraper ([illegible]) [illegible]
Street Dust and Influenza ([illegible]) [illegible]
Street Flushing, Cost of...........(43) 155
Street Flushing, Cost in Chicago..(70) 248
Street Flushing, Cost St. Paul......(68) 246
Street Flushing, Experiences, Worcester, Mass.....................(52) 230
Street Flushing and Respiratory Diseases ([illegible]) [illegible]
Street and Highway Policy, U. S. Highways Council...............(105) 391
Street Improvement—Financing.....(1) 1
Street Intersections, Increasing Radius of Turns....................(117) 521
Street Oiling, Cost Hamilton, Ont...(60) 238
Street Oiling, Cost of St. Paul....(54) 232
Street Paving Underground Study.(47) 159
Street Railway Operation "Skip-Stop Plan" ([illegible]) [illegible]
Street Railway Operation "Skip-Stop" Plan ([illegible]) [illegible]
Street Railway Track, Ties Made from Old Rails.....................(82) 368
Street Railways, Increased Fares for ............................. (49) 273
Street Railways and Railless Electric Traction, Economics of......(27) 123
Street Railways, Reducing Peak Load of ([illegible]) [illegible]
Street Railways, Skip-Stop System.(51) 285
Street Sprinkling, Cost of, St. Paul ............................ (54) 232
Streets—Inadequate Funds For.....(1) 1
Streets, Macadam Oiling............(17) 17
Streets, San Francisco, Sanitary Condition ([illegible]) [illegible]
Streets, Wash to Remove Germs...(91) 457
Stripping, Hydraulic, Quarrying..(112) 564
Stripping on Mesabi Range, Equipment (18) [illegible]
Stripping, Overburden English Practice ................................ (8) 402
Stripping, Quarry, Conveyor and Steam Shovel Work................(113) 565
Structural Engineering.............(33) 427
Structural Engineering Courses, Objects of.......................(99) 385
Structural Engineers and Architects ([illegible]) [illegible]
Structural Engineer, Definition....(109) 581
Structural Merits of Lumber.......(47) 293
Structural Steel Work, Drafting Room Errors ([illegible]) [illegible]
Stucco Finish, Cost of.............(58) 304
Stucco Tests, Bureau of Standards(101) 387
Student Officers, Training Corps..(47) 249
Students Army Training Corps....(80) 324
Students Training Corps, Course of Study ........................(66) 290
Stump, Tool for Pulling............(115) 567
Stumps, Blasting, Frozen Soil....(106) 492
Sub-Contractor ....................(113) 585
Sub-Grade for Highway ([illegible]) [illegible]
Subsoil, Water Supply for Puri....(31) 425
[illegible]
Survey, Industrial, Object of......(64) 242
Survey, Location of Earth Roads.(65) 243
Survey, Pitometer at Ottawa.....(32) 168
Surveys, [illegible]
Surveys, Land Reclamation for Appropriation ([illegible]) [illegible]
Suspension Bridge, Menai, Tests on ([illegible]) [illegible]
Swine, Feeding Garbage to.......(120) 550
Swine, Regulation for Feeding Garbage to ([illegible]) [illegible]

T

Tanks, Imhoff Rules for Operation. (6) 30
[illegible]
Tar Concrete Foundation, Brick Pavement ([illegible]) [illegible]
Tar Surfaces, Recent Practice in..(30) [illegible]
Tar Treatment of Gravel Macadam.(45) 157
Teaching, Experiment in...........(82) 326
Teaching, Novel Experiment in....(72) 316
[illegible] Method
[illegible]
Tests of Stucco by Bureau of Standards ([illegible]) [illegible]
Tests, Tractive on Roads............(3) 3
Test Values for Broken Stone......(46) 158
Text-Book Method of Teaching....(72) 316
[illegible]
[illegible]
Thawing Frozen Water Mains, Method ([illegible]) [illegible]
Thawing Methods for Water Mains ................................ (121) 551
Thawing Services Electricity.......(21) 45
Thawing Services with Hot Water.(28) 164
Thawing Water Services with Electricity ([illegible]) [illegible]
Theatre, Example of Reinforced Concrete Construction.............(32) 128
[illegible]
[illegible]
Ties, Hand and Machine Tamping.(73) 359
Ties, [illegible]
Ties, Reinforced Concrete..........(25) 419
Ties, Street Railway Track, Old Rails ([illegible]) [illegible]
Tile Foundation for Pavements....(105) 449
Tilting Dam, Gun Powder River Water Supply ([illegible]) [illegible]
Timber Bridges, 80 years old......(104) 390
Timber Cofferdam, Rapid Building.(59) 283
Timber, Picaroon .................(60) 284
Tongabuddra Bridge................(11) 405
Tongs for Handling Precast Concrete Piles ([illegible]) [illegible]
Toronto, Brick Sewer Cost........(65) 267
Toronto, Ont., C. P. Ry. Bridges...(14) 86
Toronto, Street Car Track Paving..(13) 13
Tower and Tank, Rein. Con.........(59) 261
Township Road Maintenance Illinois ................................ (14) 14
Tracings, Erasing Pencil Marks..(116) 588
Track, Testing for Motor Trucks..(126) 530
Tracklaying, For Logging Railroad.(10) 58
Tracks Street Car, Paving..........(8) 8
Tracks, Street Railway, Machine for Removing ...................(116) 568
Tractive Resistance, Hauling......(16) 16
Tractive Resistance, Industrial Trucks ([illegible]) [illegible]
Tractor, Dragging from Mud Hole.(65) 289
Tractor, For Pulling Sweeping Machine ([illegible]) [illegible]
Tractor Scraper Outfit Grading......(5) 5
Traffic, Caring For, Road Construction ([illegible]) [illegible]
Trailer Trains Starting.. ...........(7) 7
[illegible]
Trans-Australian Railway, Construction ([illegible]) [illegible]
Transportation, Three Elements..(123) 527
Trees, Roadside, Reserving and Planting ..........................(89) 343
[illegible]
Trolley Wire Blocks, Drilling Holes in Tunnel Roof for Anchoring. (95) 481
Troy Lock, Cofferdam for..........(59) 283
Troy Lock, Cold Weather Concreting ([illegible]) [illegible]
[illegible] Friction Fenders............(105) 491
Troy Dam, Method of Keying......(30) 188
Troy Dam, Test of Rock Foundation ([illegible]) [illegible]
Truck Manufacture, Unwise Curtailment ([illegible]) [illegible]
Trucks, Automatic Dump Body for.(90) 334
Trucks for Handling Concrete Aggregates ([illegible]) [illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]

U

Underdrainage City Pavements (38) 150
[illegible]
[illegible]
Underground Workings in Rand Mines ([illegible]) [illegible]

Unionization of Engineers..........(91) 377
Unions and Women Workers ......(69) 335

V

Valve Extractor, Air Drill........(126) 598
Vault, Concrete Electric Cable System, Cost ..............................(99) 385
Vehicles, Electric Cost of Operation ..............................(11) 107
Ventilation, Woodhead Tunnel.....(28) 124
Viaduct Approach, Central Avenue Bridge ..............................(4) 76
Viaduct, Masonry, 89 Years Old...(102) 388
Viaduct, Langwies Reinforced Concrete ..............................(3) 99
Vise for Repairing Air Drill......(126) 598
Voids in Concrete.................(29) 125

W

Wall, Rangoon Training............(23) 119
Walls, Reinforced Concrete Hollow Block ..............................(98) 484
Wall, Reinforced Concrete Pile....(98) 484
War, The Effect on National Wealth ..............................(1) 395
War Inventions For................(25) 161
War Work, Leadership of Civil Engineers and Contractors......(89) 375
War, Lessons of as Applied to Roads and Bridges.................(39) 433
War, Part Played by Engineers....(65) 289
War, Policy in Road Building......(16) 16
War and Science...................(49) 295
War Work, St. Paul Engineering Society ..............................(107) 513
Warehouses, Navy Cost Of........(44) 224
Wash Water Troughs, Flow of Water in ..............................(95) 461
Washing Streets as Germ Destroyer(91) 457
Waste, Spontaneous Combustion of.(22) 118
Waste of Water, Suggestions for Preventing ..............................(66) 268
Water Bill, Postal Card..........(128) 558
Water Consumption in Metropolitan Water District...............(72) 338
Water Consumption Oak Park......(11) 35
Water Consumption, "Per Consumer" Unit ..............................(26) 162
Water Consumption, Units for Comparing ..............................(110) 540
Water, Cost of Filtering...........(28) 146
Water Department, Employees School ..............................(28) 164
Water, "Doped"...................(114) 544
Water, Growths in.................(12) 406
Water Hyacinth, Fertilizing Values of ..............................(21) 415
Water Level, Device for Indicating.(66) 268
Water Mains, Concrete, Service Connections ..............................(103) 469
Water Main, Construction, Cost, Pasadena ..............................(100) 466
Water Mains, Cost, Hartford, Conn. ..............................(121) 551
Water Main, Cost, Fall River......(67) 269
Water Mains Cost, Milton, Mass..(14) 38
Water Main, Determining Most Economical Size................(920) 116
Water Main Extensions, Louisville, Ky. ..............................(11) 35
Water Main Leakage Determination of ..............................(16) 40
Water Mains, Leakage from New ..............................(117) 547
Water Mains, Leaks in. Hamilton, Ont. ..............................(58) 260
Water Main, Locating Leaks in....(84) 350
Water Mains, Old, Carrying Capacity ..............................(112) 542
Water Mains, Repairing with Sleeve Spacer ..............................(83) 349
Water Metering, Chicago, City Engineer's Recommendations....(109) 539
Water Powers, British Empire....(112) 542
Water-Power Legislation..........(47) 25
Water Power, Undeveloped U. S...(33) 169
Water Purification in the Field.....(5) 399
Water, Purification in Military Campaigns ..............................(35) 131
Water Purification, Military Campaign ..............................(35) 131
Water Purification, Minneapolis....(81) 347
Water Purity, Standards for......(104) 470
Water Rates Inadequate............(26) 162
Water Rates Raising to Offset Increased Costs...............(117) 547
Water Rates, Readjustment........(86) 352
Water Rates, St. Louis...........(11) 35
Water Service Leaks, Classification ..............................(50) 252
Water Services Cost of Installing at Louisville ..............................(19) 43
Water Services, Lead Pipe Connection For ..............................(50) 252
Water Services, Thawing Electricity(8) 32
Water, Softening..................(101) 467
Water Standards of Purity........(14) 38
Water, Standards of Quality for...(32) 168
Water, Sterilization with Ammonia.(16) 40
Water, Storage, Advantages and Disadvantages ..............................(102) 468
Water Supplies, for Rural Communities ..............................(52) 254
Water Supplies, Sanitary Aspect of at Army Cantonments ..........(94) 460
Water Supply, Hetch Hetchy, Status ..............................(126) 556
Water Supply, Subsoil, Pumping Experiments ..............................(31) 425
Water Tanks, Creosoted Wood For Railway Service...................(44) 202
Water Tanks, Wooden Life of....(110) 466
Water Towers and Standpipes ......(68) 270
Water Treatment Ammonia with Bleach ..............................(16) 40
Water Tunnel, Capacity Tests of..(67) 269
Water Waste Elimination, Methods in Oak Park..............................(74) 340
Water Waste, Suggestions for Preventing ..............................(66) 268
Water Waste Warnings............(78) 344
Waterways, Division of Inland.....(51) 275
Waterworks, Aberdeen Excess Lime Treatment ..............................(4) 100
Water Works Distribution, Services Recording Location...........(35) 171
Water Works, Effect of War Conditions Upon...................(40) 176
Waterworks Operating Expenses Increased ..............................(86) 352
Waterworks Practice, Specialization in ..............................(20) 414
Water Works Service Dionic Tester ..............................(16) 40
Wave Action Determination of....(37) 113
Wealth National, Effect of War..(1) 395
Wedge Shaped Reinforced Concrete Footings Design...........(121) 593
Welded Steel Vessel First in England ..............................(34) 214
Welding, Application of Electric to Shipbuilding ..............................(26) 420
Welding, Manufacture and Use of Oxygen in ..............................(23) 129
Welding, Electric, Steel Ship Construction ..............................(62) 308
Well, Increasing Flow by Dynamiting ..............................(104) 469
Well, Recovering Pump From......(64) 266
Wells, Special Cast Iron Lining....(36) 172
Well Drilling Method of Blasting..(52) 276
West Side Irrigation District, Calif.(42) 178
Wet Trench, Pipe Joints Made in..(68) 270
Wharves Steel, Corrosion of........(6) 104
Widening Concrete Road with Bituminous Macadam Shoulders...(129) 533
Wire Rope, Lubrication............(61) 285
Women Employed in English Munition Factories ..............................(39) 135
Wood Block on Bituminous Coating Cushion ..............................(7) 7
Wood Block Pavement.............(7) 7
Wood Block Pavements, Bituminous Filler ..............................(76) 320
Wood for the Construction of Mill Building ..............................(45) 225
Woodhead Tunnel, Ventilation.....(28) 124
Wood, Heat Values of............(28) 186
Wood Water Tanks, Creosoted....(44) 202
Wooden Ship Construction of Output ..............................(2) 74
Wooden Ships Repaired with Rein. Con. ..............................(112) 584
Wooden Ships "Salting"...........(43) 223
Wooden Water Tanks, Life of....(100) 466

# AUTHORS INDEX

A

Abrams, Duff A. (5) 77; Adams, Henry (15) 111; Allen, John R. (7) 79; Allen, R. W. (34) 170; Arnold, G. L. H. (103) 509; Ashton, Thomas N. (114) 318; Ashton, Thomas N. (71) 357.

B

Baker, E. E. (55) 279; Baker, William H. (11) 59; Ball, James B. (28) 124; Barnett, Robert C. (94) 438; Barraclough, H. L. (42) 222; Barstow, G. F. (45) 157; Bass, Frederick (29) 209; Berridge, Harold (5) 101; Blackie, A. (77) 503; Blanchard, Arthur H. (30) 142; Blanchard, Arthur H. (119) 523; Bleisteine, B. J. (56) 258; Bowles, James T. B. (94) 460; Bowles, Oliver (97) 478; Bowles, Oliver (119) 571; Bromley, A. H. Jr. (22) 84; Brown, C. A. (35) 147; Burt, Henry J. (99) 385.

C

Calder, William A. (126) 568; Carr, O. E. (41) 487; Cassidy, James E. (65) 289; Champe, S. U. (38) 196; Chandler, W. L. (72) 338; Cherrington, Frank W. (7) 7; Christie, J. M. (33) 129; Claussen, Oscar (78) 322; Clemence, Walter (27) 123; Cohen, A. B. (31) 211; Collier, B. C. (119) 591; Comstrock, William P. (102) 508; Cooley, M. E. (21) 93; Craig, James (12) 406; Crosthwaite, P. M. (31) 127.

D

Dartt, Harry (63) 241; Davenport, L. D. (18) 66; Davis, R. P. (121) 593; Desch, Cecil H. (13) 407; Drayer, C. E. (46) 182; Drinkwater, E. A. (6) 6; Dull, Raymond W. (14) 62; Dunlap, H. J. (39) 175; Dutton, Ellis R. (107) 451.

E

Edmondson, James H. (106) 472; Edwards, L. N. (59) 305; Ellis, S. H. (8) 104; Engelke, W. D. (4) 52; Ericson, Lambert T. (76) 320.

F

Farmer, John E. (9) 105; Featherly, W. V. (96) 482; Ferriss, H. R. (121) 525; Field, Frank V. (95) 461; Finley, O. W. (17) 65; Fisher, E. A. (107) 473; Fleming, R. (92) 378; Fleming, R. (113) 585; Fletcher, Robert (29) 209; Foltz, T. F. (61) 285; Fortier, Ernest C. (45) 461; Francis, John (112) 564.

G

Gilman, George H. (31) 189; Glass, E. Earl (92) 458; Glass, E. E. (74) 318; Glasco, P. B. (30) 210; Glazebrook, Richard T. (29) 423; Goldbeck, A. T. (93) 499; Graham, Allan (40) 136; Gray, E. R. (17) 17.

H

Hardenbergh, W. A. (58) 260; Harrison, J. L. (4) 4; Harrison, J. L. (59) 237; Harrison, J. L. (83) 327; Harrub, C. N. (78) 344; Hathaway, C. M. (57) 235; Hefferman, D. A. (28) 164; Hefferman, David A. (84) 350; Henry, S. T. (99) 505; Hermanos, Hume (112) 584; Hicks, H. L. (106) 450; Higbee, F. G. (82) 326; Hillman, Arthur J. (29) 125; Hollister, S. C. (57) 303; Holmes, Robert W. (13) 109; Hoover, A. Pearsons (64) 242; Houston, A. C. (20) 414; Howe, Henry M. (17) 89.

J

Jack, R. T. Grant (65) 267; Jacobsen, B. F. (124) 554; James, E. A. (37) 149; James, E. W. (86) 330; Jensen, J. A. (50) 252; Jervis, John (72) 358; Job, Robert (36) 216; Jordan, Leonard C. (116) 588; Jorgensen, L. R. (12) 36; Judd, W. A. (64) 266.

K

Kemon, F. P. (76) 342; Kershaw, C. Bertram (15) 111; Kilpatrick, G. H. (62) 264; Kinney, Wm. M. (130) 560, Knouse, Homer V. (82) 348.

L

Lakeman, Albert (34) 130; Lamb, George. N. (28) 140; La Motte, Arthur (79) 365; Lane, Franklin K. (118) 522; Lapworth, Herbert (36) 132; Ledoux, J. W. (8) 32; Little, Arthur D. (18) 90; Longwell, J. S. (97) 463; Loucks, R. E. (65) 243; Loughlin, G. F. (118) 570; Lowell, J. W. (97) 441; Loweth, C. F. (122) 594; Loweth, C. F. (125) 597; Lynch, W. J. (85) 371.

M

Machen, Henry B. (54) 256; MacKendrick, William G. (15) 15; MacKenzie, H. Ross (43) 155; Manns, Charles R. (111) 563; Edgar Marburg. (23) 95; Marcellus, J. B. (5) 29; Marshall, R. C. (115) 567; Marriott, T. G. (124) 528; Mason, W. P. (50) 274; Matte, H. P. T. (74) 340; Maughan, Walter (39) 433; Maxwell, W. H. (36) 172; McArdle, P. C. (85) 329; McClure, W. F. (71) 357; McDonnell, R. E. (10) 34; McLean, A. C. (41) 221; Miles, E. L. (52) 254; Mohlman, F. W. (30) 166; Moore, John J. (117) 547; Morgan, Ben. H. (35) 429; Morse, Robert B. (32) 168; Mullen, Charles A. (9) 9.

N

Nasmith, George G. (7) 31; Nichols, C. E. (36) 194; Nunn, Herbert A. (79) 323.

O

Orchard, William J. (14) 38; O'Shaughnessy, M. M. (112) 542; Overholt, H. G. (59) 261.

P

Pearson, J. C. (101) 387; Pearce, S. L. (11) 107; Perkins, Wm. C. (105) 449; Phelps, H. E. (40) 152; Piepmeier, B. H. ([illegible]) 14; Pollock, Water (15) 409.

R

Race, Joseph, (16) 40; Reeves, Frank (23) 119; Redfield, Wm. C. (123) 527; Renwick, Edward A. (40) 220; Rhodes, A. T. (52) 230; Rice, John M. (122) 552; Riker, Charles E. (106) 512; Roberts, H. W. (93) 479; Robinson, F. S. (65) 311; Rogers, Edwin H. (35) 171.

S

Sawyer, W. B. Jr. (39) 151; Schaack, David Van (40) 198; Scherer, R. W. (129) 533; Scott, A. Alban H. (24) 418; Scott, James (22) 118; Sewell, H. A. (33) 145; Shelmire, R. W. (53) 231; Shonts, Theodore P. (123) 575; Siems, V. Bernard (61) 263; Sinclair, Russell (7) 401; Speller, F. M. (51) 297; Steward, W. G. (114) 543; Stewart, Murray Alexander (13) 13; Stickle, H. W. (59) 283.

T

Thompson, James (24) 120; Torkelson, M. W. (107) 513; Trounce, H. D. (86) 372.

V

Van Cleve, Horatio P. (95) 501; Vaughan, G. W. (53) 359.

W

Walden, A. E. (72) 338; Walls, J. A. (85) 351; Whipple, Melville C. (102) 468; Whittaker, H. A. (55) 257; Wig, Rudolph J. (57) 303; Wigg, R. J. (16) 88; Wiley, Rodman (131) 535; Wiley, Rodman (74) 318; Willis, Charles F. (81) 367; Woedtke, Leo D. (53) 299; Wolman, Abel (32) 168; Wolman, Abel (80) 346; Woodfall, J. Leslie (21) 45; Worrell, J. C. (91) 377.

*Road and Street*
*Monthly Issue*

ENGINEERING AND CONTRACTING

HALBERT P. GILLETTE, *President and Editor.*    LEWIS S. LOUER, *Vice President and General Manager.*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering field. See advertising page for further information and [illegible]

**Roads and Streets—1st Wednesday**
(a) Roads (c) Street Cleaning
(b) Streets (d) [illegible] Miscellanies

**Waterworks and Hydraulics—2nd Wednesday**
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power

**Railways and Govt. Works—3rd Wednesday**
(a) Excavation and Dredging (c) Harbors and Docks
(b) Rivers and Canals (d) Railway Construction

**Buildings and Structures—4th Wednesday**
(a) Buildings (c) [illegible]
(b) Bridges (d) Miscellaneous Structures

Volume L    CHICAGO, ILL., JULY 3, 1918    Number 1.

# Why Funds for Roads and Streets Are Usually Inadequate for the Needs of the Public

Until the last decade capital for railway construction was available in abundance, and new railways and betterments were provided not only as fast as needed but often far in advance of existing requirements. On the other hand, although capital for roads and streets was available, it did not "seek investments in such highways and was sought in relatively small amounts. Consequently plant for railway transportation far outstripped plant for highway transportation, although the latter was economically as important as the former. This condition still exists, in spite of all that has been done in recent years to "boost" the good roads movement.

It is important to seek the underlying reasons for this difference in development of roads and railroads, for, if the causes are clearly recognized, more intelligent action will result. The reason why capital sought investment in railways was the expectancy of a profit in excess of interest rates on public bonds. Railway profits were secured, if at all, as a result of economy of construction and operation; and the revenues were secured directly from those who shipped goods or themselves traveled by rail. In short, each railway company was a device not only for transporting men and "goods" but for collecting revenues and disbursing costs and profits. This last function is important, for upon it depended the fact that capital sought investment in railway properties.

Turn now to another picture—the public highways. Here there is no collection of revenues for the use of the roads and streets, save the small sums paid as taxes on vehicles, and there is therefore no distribution of profits. Consequently there is no direct measure of the total economy effected by the existence of highways. But, to make a bad matter worse, the highways are not paid for by those who use them, except in small part and then indirectly. Without a measure of the real worth of good roads is it to be wondered that road improvement has never kept pace with railway development? What would American railways be today had there been no direct revenue from their use, and had the raising of capital for their construction and maintenance been effected solely by taxing the real estate contiguous to the railways?

It is certainly good economics to make every public utility self-supporting, if practicable. The users of city water pay for it as they use it, and abutting property is not ordinarily taxed to secure capital with which to build water works additions and improvements.

Private toll roads were operated so as to make the users pay for their use, but with the purchase of such roads by the public the toll system was abolished. It may well be questioned whether the toll system should not be revived. Certainly there can be little doubt that a "wheel tax" should be placed on all vehicles in amount sufficient to maintain the highways once they are built; and the belief is growing that the "wheel tax" should also provide at least part of the interest on the investment in the highways.

It is contended that public highways should be free. There is a charm in that word "free," but it is a charm that conceals many an economic mistake. It has led to the fallacy of not metering city water, "because water should be nearly as free as nature made it." Now, no public plant of any kind, water works or highways, is secured without cost. So the question is not one of entire freedom from cost but of freedom from payment directly by those who use it.

We believe that if public highways had not been free to the users, but if adequate wheel taxes had existed in all cases and tolls in some cases, our roads and streets would today be comparable with our railways in point of general development and excellence. An uneconomic and unjust system of taxation for road and street improvement and maintenance accounts for the fact that barely 10 per cent of our country roads and 40 per cent of our city streets and alleys are paved.

Let us not delude ourselves into thinking that in the past few years we have made great progress in road improvement. We have scarcely begun to make up for our almost complete lack of highway development during the last century.

## Day Labor vs. Cost Plus a Fee Contract for County Road Construction

In normal times counties do a large part of their road work by day labor. About half the counties build all earth, gravel and macadam roads by day labor. On the other hand, nearly all county concrete and brick roads have been built by contract. War conditions are causing counties to do proportionately more work by day labor, so that it is likely that hereafter more counties will lay concrete, asphalt and brick pavements by day labor than heretofore.

It is not unlikely, however, that some form of cost plus a fee contract will come into extensive use for county road work; for, under such a contract, skilled construction management can be secured and at the same time a road building plant can be hired from the contractor. Moreover, workmen are not so apt to "loaf" when working under a contractor as when working directly for the county. If the contractor's "fee" is on a sliding scale, increasing if the work is efficiently managed and decreasing if it is not, nearly all the economic advantages of the old form of unit price contract can be secured.

Road contracting is hazardous any time, and more so during such times as these. Hence there is a growing tendency among civil engineers to favor cost plus a fee contracts for road work. Often there are laws that do not provide for that form of contract. In such cases engineers should take steps to secure amendments to the laws as quickly as possible.

## What the City Managers' Association Is Doing and Has Done

Engineers who are interested in the profession of city management will find a great deal of instructive and inspiring information in the Fourth Yearbook of the City Managers' Association, just published.

There are listed in this year book 121 city-manager municipalities. The population of each city is given, also the name of its manager and his salary. Some 25 pages are devoted to brief achievement reports by the members of the association, and 14 pages contain photographs of the 54 members. The rest of the book contains addresses and discussions relating to the problems that confront city managers. There are many excellent, practical suggestions in these addresses and discussions.

The secretary-treasurer's report shows that only half the total number of city managers have joined the association, and he says: "Comparatively few of the managers seem to have any conception of the value to them and their city, and the movement for better city government, which this association holds out for them."

This is one of those associations that is clearly entitled to have as members 100 per cent of all that are eligible. Moreover, it should have the support of many civil engineers, particularly city engineers. We believe that a large number of non-active members would join the association were an associate membership made available. The annual dues of a member are only $5. Why not provide for associate membership at, say, $1 a year? Engaged in municipal work there are thousands of civil engineers, who, it seems to us, would be glad to join this association not only in order to profit from the papers presented at its meetings, but to learn how to assist in the great campaign for better municipal government.

The Fourth Yearbook of the City Managers' Association contains 130 pages and may be secured for 25 ct. from H. G. Otis, Secretary City Managers' Association, Auburn, Me. Copies of the yearbooks for each of the three preceding years may be secured for 15 ct. each.

## "Fresh From the Garden"

The average city resident has a choice of two kinds of vegetables, the kind that's canned and the kind that's "kind o' wilted." There are no other kinds at present for the average city man. But if smooth, hard roads radiated from every city far into the country, it would not be long before "fresh from the garden" vegetables would be the rule rather than the exception.

City readers, listen to the following, and renew your hope that some day you may enjoy radishes with the "pep" still in them, and peas with the wilt not in them.

> The Post Office Department has inaugurated two parcel post motor truck routes from Virginia into Washington, D. C. By this means it is expected to bring the Washington produce consumer into direct contract with Virginia farmers. One route will run from Washington to Whites Ferry, the other from Washington to Middleburg, each including all of the important centers and farms en route. The trucks will leave Washington at 11 o'clock every morning, reach their destination at 2:30 in the afternoon of the same day, and make the return trip leaving the Virginia terminus one hour after arrival. This will allow the Washington householder to send an order to a Virginia farmer by morning mail and receive the desired food fresh the evening of the same day.
>
> C. R. Wilson, District of Columbia Food Administrator, is trying to devise some means of insuring the farmer that he will be paid promptly for his produce and insure the produce buyers that they will receive fresh produce. This may be accomplished by a reference bureau to serve as a clearing house for the farmer and consumer.
>
> The innovation of these routes will be closely watched by Washington officials, as they form the experimental basis for considerable enlargement of the plant with establishment of other routes in co-ordination with food administrators throughout the United States.

Evidently the Post Office Department is planning to use motor trucks on a large scale in its rural parcel post business. But to do this economically it will be necessary to provide a better system of rural highways that now exists around most of our cities.

## "To Know How Is to Succeed"

On an advertising leaflet recently issued by the Department of Agriculture appeared the slogan, "To know how is to succeed." Perhaps a more precise statement would be, "To succeed, you must have knowledge." The possession of knowledge does not, of itself, insure success; for success depends also on energy, persistence, and other qualities, not to mention "good luck." Nevertheless, young men can not be told too often that "knowledge is power," for most young men are prone to give up systematic studying upon leaving school or college. That they do so, as a rule, is itself evidence that their schooling has been defective. Proper schooling not only makes the student keenly conscious of the practical utility of scientific knowledge, but inculcates the habit of seeking knowledge.

Go into any public library and observe what a very, very small percentage of the population uses any of its books at all, and then inquire what proportion of the books so used are scientific or instructive. Go even to the library of an engineering society and note the scattering few who use it regularly as a tool. After such visits you will realize how nonstudious the great majority of men are, even among those that are presumed to depend entirely on their brains for a livelihood.

The stark fact is that very few men are habituated to search continuously for knowledge. Doesn't that explain quite satisfactorily why so few men rise above the level of mediocrity? Doesn't it explain why uneconomic tools and methods remain in general use years after much better tools and methods have been devised? For 30 years the "fresno scraper" has been in general use on the Pacific Coast, in place of the "drag scraper," but the "fresno" still remains almost unused east of the Mississippi, in spite of its economic superiority. When such a simple and inexpensive tool as the "fresno" is unable to displace the "slip," after more than a generation of use, it is evident that more complex and more expensive devices must face even greater resistance to introduction. Yet if all users of tools and machinery for earth moving were merely to read the published records of cost under given conditions, scarcely any inferior device would remain long in use. The inference is that only a small fraction of the users of tools and machinery study and analyze published data.

All men grant that success is founded on knowledge, yet few follow the obvious deduction from this generalization, namely, that systematic study should continue throughout their lives and not end on "commencement day" when diplomas are received.

## To What Extent Does a Pavement Act as Arch?

Clifford Richardson, Consulting Engineer, in discussing the Progress Report of the Special Committee for Road Construction of the American Society of Civil Engineers, said:

> It is stated that [illegible] for [illegible] the center of the slab to the edges.
>
> In the writer's opinion, this is extremely bad practice. A concrete pavement should be considered as an arch, and that portion of its abutments should be thicker than at the center. The many longitudinal cracks which occur in concrete surfaces appear to the writer to be due to the fact that such surfaces have not sufficient lateral support when any settlement occurs in the sub-soil foundation. A concrete pavement or road surface should be built on the principle of bridge design, as it is really a bridge over a sub-soil.

In our issues of Dec. 5, 1917 and Feb. 6, 1918, we have expressed a similar objection to reducing the thickness of a pavement toward its edges. Mr. Richardson evidently had in mind a wide pavement on a city street, whereas the Special Committee had in mind a relatively narrow pavement on a country road. Only on a wide pavement would the arch action be of sufficient importance to merit consideration, and even there it would probably play a relatively small part because the arch is so flat. Furthermore, an arch without rigid abutments could not be counted on to sustain a load with safety.

Is "a concrete pavement or road surface really a bridge over a subsoil"? Yes, but it is not one type of a bridge. It is both a beam and an arch, but it differs from an ordinary bridge in that it is supported by a continuous abutment, or series of abutments, namely, the subsoil. Therefore it is impracticable to apply ordinary methods of bridge design to the problem.

The loose ballast of a railway track serves to distribute over the soil the concentrated loads on the cross-ties, by what may be called the "arch action" of the fragments of stone. But this is not the sort of an arch which Mr. Richardson has in mind. Macadam and gravel pavements have an arch action very much like railway ballast; and if the "binder" is strong there is also a beam action. In concrete the beam action is considerable, but it has never been proved to be predominant.

## Tests of Power Conserved by Electric Trucks, Showing the Economy of Hard, Smooth Roads

An electric motor truck can be effectively used to demonstrate the economy of good roads, for accurate measurements can be made of the power required to drive the truck over any kind of road surface. Some rather startling results have already been secured by such tests. For example, a General Vehicle 5-ton electric truck made a run in March from New York to Washington, D. C., and on one 12-mile stretch, between Wilmington and Newark, Del., used 20 amperes of current per mile. On city streets the same truck used 9 amperes per mile.

On this basis a 5-ton gasoline truck would consume about 6.5 ct. worth of gasoline per mile of city street and 14.5 ct. per mile of road like that between Wilmington and Newark, Del. Hence a day's run of 100 miles would cost $8 more over a poor road than over a good one, for gasoline alone. What would be the added cost of tires and repairs no one knows, but, without doubt, it would total a good many dollars daily. Tests should be made to determine the effect of poor highways on repair and tire expense.

## Fine vs. Coarse Sand for Pavement Grout

The construction of two sections of brick highway in New York state under identical conditions afforded a chance to compare the qualities of sands used in the cement grout. On one section the sand used was fine, sharp and gray, 87 per cent passing a 20-mesh sieve and 39 per cent passing a 50-mesh sieve. For the other section the sand was coarse and sharp, 28 per cent passing a 20-mesh sieve and 6 per cent passing a 50-mesh. The voids and loam contents were as follows: Fine sand, 36 per cent voids, 5.2 per cent loam; coarse sand, 30.4 per cent voids, 4.8 per cent loam. The coarse sand was accepted by the state highway laboratory for all classes of concrete, while the other sand was reported as too fine for concrete but was accepted for grout. On the road where the fine sand was used traffic and other causes have removed small patches and occasional strips of surface grout. No such trouble has occurred on the road where the coarse sand was used in the grout.

**To Determine Internal Wear on Macadam.**—An interesting plan for obtaining data on the internal wear of a macadam road is to be tried out by the Maryland Roads Commission. A section of highway is to be built and each item of material entering into the construction will be weighed. After a year's use the road will be taken up and the material re-weighed, thus securing the loss in weight.

# Notes on Highway Design: Subgrades

By J. L. HARRISON.

Highway subgrades are an evolution. The farmers used to "turnpike" their roads by digging out the ditches and throwing the material so secured onto the traveled way. To somewhat improve conditions they sometimes also cut off the tops of the hills to fill the low places. This was of some advantage, for it shortened the grades, if it did nothing else. Most of this work was, however, done without any engineering supervision and so was somewhat lacking in effectiveness, but served to create the impression that a highway must be raised at least a little above the surrounding country.

In the meantime the railroads of the country were being constructed and, as the nature of their motive power prevented the use of steep grades, it became customary to dig deep cuts and to pile up high fills in order to maintain a gradient which was within the possibilities of the railroad motive units. This further accustomed people to the graded traveled way and accentuated the idea that a highway must be raised above the surrounding land—in other words, must have a raised subgrade. So it has come to be an accepted fact that a road must have a raised subgrade, though, so far as one can judge from the literature on this subject, no one knows much of anything about why such a subgrade is used, how high it ought to be built, or when or whether it may sometimes be omittel. Yet if the designing of highways is ever to become other than the sort of rule of thumb procedure which it is now—the construction of a certain type of surfacing of a certain thickness in the hope that it will hold up under the traffic—the subgrade must come in for careful examination and thorough study.

**Wrong Assumptions as to Strength of Subgrades.**—As matters now stand, highway engineers make assumptions as to the strength of subgrades which no other class of engineers would make in regard to any surface stratum except rock. Thus, assume a modern macadam road 6 in. thick. Also assume an ordinary 5-ton truck. Under very ordinary overload the gross weight of truck and vehicle will be 10 tons, of which as much as 7 tons may rest on the rear wheels. Such trucks run at a high rate of speed—often 15 or more miles per hour—and in passing over irregularities in the surface of the road impact results which may be assumed to generate stresses of at least four or five times the dead load stress. It would seem, then, that it is a fair assumption that impact stresses amounting to 15 tons may frequently be generated under the rear wheels of such a truck when it is passing over a somewhat irregular surface.

Such trucks are variously tired, but assuming an area of contact between truck wheel and road surface 2 in. wide and 10 in. long, and a spreading out of the load at an angle of 45°, it develops that the load is delivered to about 297 sq. in., or a trifle over 2 sq. ft. of subgrade. (As a matter of fact, the experiments of the Office of Public Roads and Rural Engineering indicate that the area is even less than this.) This is equivalent to no less than 7½ tons to the square foot, a load which a structural engineer would hesitate to impose on anything but solid rock!

**Pavement Failures Often Due to Overload.**—This illustration has been purposely made rather extreme to show that the numerous pavement failures of recent months, most of which are so blithely laid to "weak subgrades," "wet subgrades," etc., are in reality due to overload, and that calling them by any other name merely serves to confuse the issue. It is true that subgrades are weaker at some periods of the year than at others. It is also true that some subgrades will always carry heavy loads, while others are always weak, but the outstanding fact is that we know little or nothing about what any subgrade will carry under definite and specific conditions, and still we are placing onto these subgrades loads which are as heavy as should be imposed on solid rock!

There is a great deal of talk about remedies for defective subgrades, such as better drainage, greater compaction, etc., and there is no doubt that much can be done along these lines, but why not face the problem squarely and really design the road crust as other structures are designed?

**Pavement Surfaces Should Be Designed as Carefully as Any Other Structure.**—If a bridge engineer has a heavy abutment to erect he either drives piles for it to rest on or spreads the footing until the load is so distributed over the stratum on which the structure rests that the unit loading is well within the carrying capacity of the stratum. He very rarely endeavors to increase the carrying capacity of a stratum by compacting it, for he knows that this is both a difficult operation and one of doubtful advantage. Neither does he assume that the most favorable conditions as to carrying capacity will always prevail. On the contrary, he assumes that the unfavorable conditions will always prevail and allows a reasonable factor of safety to provide against failure during such periods. Finally, he makes actual tests of the carrying capacity of the soils with which he must deal, so that instead of working entirely in the dark he may at least have a fair idea of what the real supporting power of a stratum is.

As opposed to this system the highway engineer usually lays a road crust—which is in reality a continuous foundation for the loads moving over it—with an arbitrarily selected thickness which has been chosen without any calculated or well-established reference to the loads which will use it or to the supporting power of the subgrade on which it will rest. In most instances the highway engineer who is responsible for the selection of the thickness of the road crust does not know what the supporting power of the soil he must build on is, nor does he know what, if any, benefit he will obtain by using 1-ft. or 3-ft. or any other depth of fill under his pavement. Moreover, if concrete base costs $2,000 per inch of depth per mile of 18-ft. roadway, the problem naturally arises as to whether, say, an 8-in. base laid without any fill under it, or a 6-in. base on a 2-ft. fill, or a 6-in. base well reinforced but without any fill under it, will be the most efficient for a given condition. Given data as to the supporting power of the subgrade on which a pavement is to be placed, such problems could be solved readily enough in a designing room with at least as much accuracy as is now secured in the design of such structures as foundations, retaining walls, etc., but for some reason their actual solution is never turned over to the designing engineers.

The writer believes the major trouble lies in the fact that engineers and engineering periodicals usually refer to pavement failures as due to weak subgrades or to poor drainage. It, of course, may be admitted that there is some justification for such a method of expression, but any such method of referring to this matter overlooks the fact that the subgrade is, in its very nature, subject to limitations and that there are periods of the year when these limitations are extremely low. If a pavement fails because the carrying capacity of its subgrade has fallen below what might reasonably have been expected of it, that is a failure due to weak subgrade, but if it fails, as hundreds of miles of pavement are now failing, because of the enormous truck loads which are being run over them, it is a simple matter of positive overload, and if such failures are to be prevented in the future pavement surfaces must be designed just as carefully as other structures are designed.

## Results of Abrasion Tests On Bed Rock

Studies are now being conducted by the Department of Mines of Canada upon the variations in the road-making qualities of bed rock, boulder aggregates and gravel. Records of some of this work were given by L. Reinecke and K. A. Clark in a paper presented at the recent meeting of the American Society for Testing Materials. The conclusions drawn from the results of the investigation on bed rock include the following:

The results of an abrasion test is liable to an error of 0.2 per cent due to variations caused by laboratory procedure.

Results of abrasion tests on rock in place in a deposit represent, within a probable difference of 0.4 per cent, the percentage of wear that will be shown by a crushed product produced from the deposit.

In the case of deposits consisting of stone of a very uniform character and appearance, the results of abrasion tests on samples taken at one point in the deposit can be regarded as representing within the probable error due to laboratory manipulation, the percentage of wear of the stone over quite a considerable area, at least a quarter of a square mile.

It is possible to assign average values and fairly narrow limits of variation of this value for the percentage of wear and the toughness of the material occurring in a limestone formation covering areas up to 50 and 60 square miles, and with thicknesses up to 500 ft., even though stone of quite different character is included in the formation. These values and limits will apply to the majority of results of tests made on samples collected throughout the formation and its various horizons.

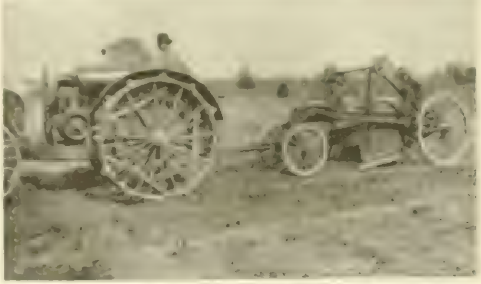
These limits should define the maximum variation of the results of abrasion and toughness tests made on samples collected from a quarry in a limestone formation to represent the material produced from the quarry as operations are extended from year to year. They should assist in determining at what intervals part vertically and horizontally it is necessary to sample formations consisting mainly of limestone or dolomite in order to arrive at their average percentage of wear and toughness values, and variations from such values.

The results of abrasion and toughness tests over a series of diabase dykes of the same age and structure reveal very uniform results in deposits of the same grain. A change in grain affects the toughness value slightly. The number of samples taken in dykes of this character need therefore not be great even though they cover large areas, if structural conditions and the texture and degree of alteration of the stone remain the same.

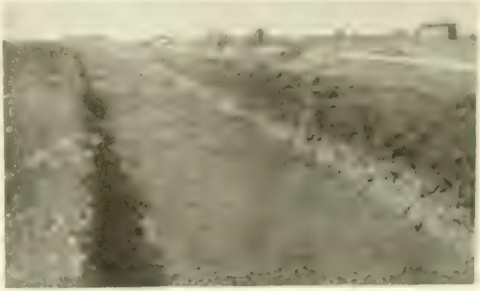
**Removing Ice from Car Tracks with Road Scarifier.**—A road scarifier was used successfully by an eastern street railway company for removing from the tracks the glaze of ice resulting from a heavy sleet storm. The scarifier was drawn along the track by an old car. It is stated that fully 100 men would have been required to do the same work.

## Tractor-Scraper Outfit on Street and Sidewalk Grading

Street grading for a large residential development near Dayton, O., was handled by a light tractor attached to a Maney four-wheel scraper of 1 cu. yd. capacity. The contractor, Mr. N. E. Redder of Dayton, having disposed of his teams because of the present high cost of keeping them, decided on the use of the light tractor as a substitute for animals. His initial use of this method was on a short haul of about 80 to 90 ft. Only two men were used on this part of the work—the tractor operator and the scraper operator. The Maney scraper, being self-loading and self-dumping and carrying about 1 cu. yd. of dirt to the load, was easily handled in this manner. On this work no plowing was necessary, as the direct power of the tractor was used for digging, loading and hauling. A round trip was usually made in about 2 minutes or at the rate of about 30 yd. an hour. The cost of operating was stated to be 80 ct. per hour, making the cost per cubic yard about $2\frac{3}{4}$ ct.



Light Tractor Loading 1 Yard Scraper



Sub-grade for Cement Sidewalk Cut with Scraper

The tractor and Maney scraper were also used in the same manner for the rough excavating for sidewalks. The cutting was made to within an inch or so of grade and eliminated considerable hand work.

The tractor used was a Huber 4-cylinder 12-20 HP. made by the Huber Mfg. Co. of Marion, O. The Maney 4-wheel scraper is made by the Baker Mfg. Co., 506 Standford Ave., Springfield, Ill.

## Building a Bituminous Pavement with a Concrete Mixer and a Macadam Roller[*]

Since 1911 I have laid no pavement other than the hot mix type, and according to the requirements used for city pavement, sheet asphalt where grade was flat on concrete base, varying from 5 to 10 in. thick, according to the amount and class of traffic. On the same grade I have used the asphaltic concrete (Topeka mix) on concrete base, which requires 4 per cent to 5 per cent less asphaltic cement than sheet asphalt, and therefore is lower in initial cost. On grades upward of 5 per cent it is necessary that larger stone should be employed in the aggregate. This can only be done with the consent, and under the Warren Brothers' patent, covering bitulithic and Warrenite pavement.

These pavements all entail a costly and immobile plant and considerable area to carry out the work of preparation of paving materials, and I propose to deal with the construction method that may be used to construct a fairly well-proportioned and thoroughly mixed pavement that will carry any class of traffic, and be constructed as continuously as any other type, and regardless of water supply, by machinery of low cost, and mobile, viz., the ordinary concrete mixer with the heating attachment, traction wheel and distribution arm, that can be obtained from the many manufacturers of contractors' plant. After the base has been prepared in the manner decided upon, and ready to receive the wearing surface, the machine can be placed on the traveled way or pavement area and the material distributed along the line of work. It is preferable, however, if there is space available on the side of roadway, to place the machine there and protect the base, the construction to be carried out as follows:

**Mixing with a Concrete Mixer.**—Stone aggregate to be of a size that will pass a 2½-in. ring and retained by a 1½-in. ring, to be placed in the mixing drum and the hot blast applied. When the stone is heated to a temperature of approximately 250° F. the asphaltic binder, previously heated in a portable heater to a temperature of not less than 200 and not more than 275° F., is then added to the already heated stone, the quantity to be within the limits of 12 per cent to 13 per cent by weight of the total quanttiy of stone in the mix.

A standard mixer of ¾-yd. capacity will turn out 800 to 1,000 cu. yd. per day, or 200 yd. of 16-ft. roadway per day, and can be operated either by steam or gasoline power and the heater be provided with crude oil burners. The traction attachment makes it possible to eliminate considerable haulage delay, and the machine can be kept always alongside the work being laid.

**Laying.**—When the stone is thoroughly coated, the batch should be emptied as soon as possible and carried by the distribution arm, or any other means convenient to use, to the dumping platform, if macadam base is used; if concrete base, on the base, within spading distance of the laying point, the mixture to be laid either by spade or fork, level, and even to a depth of 3 in., loose, and well packed into position.

**Rolling with a Macadam Roller.**—When slightly cooled off, the rolling by a 12-ton macadam roller follows, care to be taken that the line and camber is maintained. Any hollow spots must be immediately leveled up during the rolling, and the roller kept moving until the paving is thoroughly compacted. When this is done, and before the pavement is cooled, the mix in the machine should be changed.

**The Surface Coat.**—And a mixture of three parts of stone, one part of rough sand, heated as the stone, and mixed with 12 per cent to 13 per cent asphalt cement, heated to the temperature of not less than 225° or over 275° F. and the stone and sand to be thoroughly coated. When the mixing is completed, a surface treatment is given to the already laid and still warm pavement to a depth evenly laid of approximately ½ to ¾ in. in thickness, and as soon as laid the roller started again, to drive this coat into the voids that may exist between the previously laid stone; and here care should be taken to watch that any parts of the surface needing extra material should receive it during the first rolling, when it will manifest itself. When sufficiently rolled, the whole pavement should be then just covered with a coat of warm stone chip of ¼ in. down, and as soon as cooled off the pavement may be used for traffic.

Any well-known brand that will fulfill the standand specification requirements, of a penetration of from 60 to 90 at 77° F. will be satisfactory material to use for this class of work.

I find the asphaltic cement binder a satisfactory material to use, due to the fact that its natural ductility allows ample time for compacting before setting up. It is less subject to variation of temperature than any other material, and climatic changes have no effect. In spring and fall it does not get excessively hard and slippery, and in summer the heat does not have any appreciable effect, and at all times will it carry any load that the foundation will carry. It will give good service, is easy to repair, and is low in maintenance cost.

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[*] From a paper presented at the 5th Canadian Good Roads Congress by E. A. Drinkwater, Municipal and Highway Engineer, St. Lambert, Que.

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## Spare Tower Hopper for Car Unloader

Where aggregate is used direct from the cars to the mixer, unnecessary handling can be eliminated and the number of men required reduced by hanging to the side of the car a standard steel tower hopper, states Mr. Glen H. Thompson in Concrete. The hopper serves as a reservoir, into which four men can shovel while one man operates the sliding gate at the bottom and changes the wheelbarrows as they come up. A hopper can of course be built of wood for the same purpose if the steel hopper is not at hand. The hopper should be hung with hooks in such a way that it can be slid along the side of the car, so as at all times to have the shovelers close to their work.

Comparison between this method of unloading and the old way, where the cars were unloaded to the ground and the material reshoveleld into the wheelbarrow, is as follows:

OLD WAY (1½ OR 2 3:5 MIX).

| | Hours. |
|---|---|
| Unloading one car rock, 14 men | 28 |
| Sand, 14 men | 10½ |
| Rock, 5 wheelers | 22½ |
| Rock, 5 loaders | 22½ |
| Sand, 3 wheelers | 13½ |
| Sand, 3 loaders | 13½ |
| Total | 110½ |

Requires the use of 16 No. 2 shovels.
Some material wasted.

NEW WAY.

| | Hours. |
|---|---|
| Rock, 5 wheelers | 22½ |
| 5 men unloading rock | 22½ |
| 3 men wheeling sand | 13½ |
| 3 men unloading sand | 13½ |
| Total | 71 |

Requires the use of 6 No. 2 shovels.
No spoiled material left.

# Separated Creosoted Wood Block Pavements Laid Directly Upon Concrete Foundation With a Bituminous Coating Cushion and Filler

By FRANK W. CHERRINGTON,

[illegible]

A few years ago it would have beeh considered absolutely impractical to specify a creosoted wood block pavement to be installed with four sides of the block and the bottom thoroughly and efficiently sealed against the possible absorption of moisture. With the advent of practical means and methods of separating the individual units of the pavement uniformly, so that the filler may penetrate the full depth of the block on all sides, and economic methods of bringing the concrete to a smooth finish, this long-sought permanence and rigidity of construction has been made possible.

The disturbance of the contour of the finished pavement through the shifting of the sand or mortar cushion, together with the absorption of moisture from pockets forming in such cushions, have long been inherent defects of wood block construction. The elimination of the cushion, the substitution of a pitch paint coating, the floating of the concrete to a smooth finish, the use of uniformly separated blocks, and the application of a high melting point pitch filler have made it possible not only to effectively seal the bottom of the blocks, but all sides, as well.

The practice of installing creosoted blocks directly upon a smoothly finished concrete foundation has been used on a large scale for many years abroad, both with and without the bituminous coating as a cushion. Blocks were first laid in this country directly upon the concrete with a coating of pitch 6 or 7 years ago in a small Minnesota municipality. Several years ago the cities of Chicago, Pittsburgh, St. Louis and others installed blocks in this manner under heavy traffic conditions, and the results have been so satisfactory that the city of Detroit after extensive investigation, is now using on a large scale the bituminous coating cushion with distinct success. This year it will also be extensively used, with separated wood block pavements, in Milwaukee, Wis., Cleveland, O., and Newport, Ky.

During the summer of 1917 the city of Toledo adopted this specification for the installation of approximately 25,000 yd. of separated wood block construction on streets with and without car tracks, and for paving between the rails.

The concrete was brought to a true and even surface and then floated with a light metal concrete roller. After permitting the concrete to dry out for 5 days, the surface was given a paint coating of coal tar pitch with a melting point of about 140° F. After hardening, the blocks were then laid directly upon this coating and the joints between the blocks filled with hot pitch to within about one-third of the distance to the surface. The filler was squeegeed over the surface of the blocks while very hot, care being taken to see that a minimum quantity or a very thin film remained upon the surface of the pavement. With one application the joints may be filled flush with the pavement surface and as the pitch cools a space of about 1 in. will be left in the upper portion of the joints. The balance of the interstices between the blocks are then filled with dry sand. The presence of the sand in the upper portions of the interstices is to counteract the excessive exudation of the pitch between the blocks to the surface of the pavement in hot weather. The coefficient of expansion of pitch is so high that unless this precaution is taken in hot weather the pitch will be exuded in large quantities to the surface of the street. With the sand in the upper portion of the interstices, instead of pitch being exuded, sand only will be forced out on to the surface of the pavement.

In the street car tracks and dummy, instead of placing a crown in the pavement, the ordinary construction was reversed, the surface being concaved instead of convexed and track drips placed at intervals of about one city block or approximately from 300 to 400 ft. The theory of track construction of this character is that the crown in the street car tracks throws the water to the rail and it eventually seeps under the pavement with subsequent damage. The concave surface between car tracks will throw the water to the center, where it is carried to the track drips and thence to the sewer. Last summer the area between the tracks was concaved about 1 in., but this year will be increased to about 1½ in. This construction for car tracks is only satisfactory, of course, where there is a sufficient grade to enable the water to flow as it would be of no use on streets where there is no appreciable grades.

The pavements installed directly on smoothly finished concrete with bituminous cushion in Toledo have been watched very closely, and although the past winter was one of unusual severity they came through in almost perfect condition.

The cost of this type of construction is less if anything than the mortar bed. The floating of the concrete to a true surface is a very simple and economical operation. The paint coat of pitch is inexpensive, requiring approximately ½ gal. of pitch per square yard of surface.

There is also a distinct economy in labor as well as a decided saving in the materials necessary for installing the blocks with this method in comparison to installation over a mortar cushion.

It has been found that coal tar pitch both as a coating and filler gives much better service than asphalt. The pitch adheres more tenaciously to the concrete foundation with one application than the asphalt, consequently blocks will be held more rigidly and firmly in position. Asphalt poured over concrete as a bituminous coating with the blocks imbedded in same, may very easily be lifted in whole sections from the foundation, while if pitch is used, it requires about 150 lb. per square inch to pull the blocks free from the concrete foundation. Asphalt may only be used successfully if a paint coat of light oil is first given the concrete before the application of the cushion coat.

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**Tractor Hauls Machine Broom for Sweeping Road Preparatory to Oiling.**—A machine broom street sweeper drawn by a tractor is employed with great effectiveness by the Street Department of Worcester, Mass., in preparing road surfaces for the application of light tar and road oils. The sweeper is equipped with a sprinkling device which keeps down the dust.

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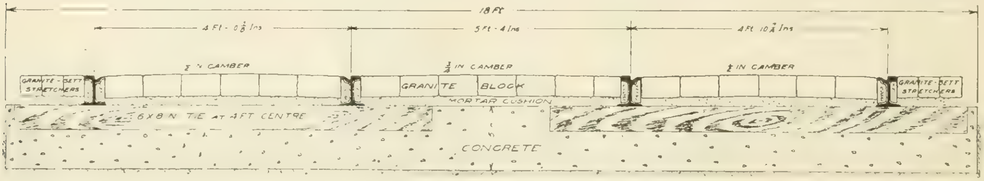
**Hint for Starting Heavily Loaded Trailer Trains.**—By placing a tractor at right angles to the loaded trailer train it is possible to start much heavier loads than by the ordinary straight pull.

# Granite Block Between Street Car Tracks Using Cement Mortar Cushion

Three classes of street railway track paving are employed at Toronto, Ont. The best results to date, however, seem to have been secured by granite blocks, laid with close joints on a mortar cushion, and a creosoted wood block filler for the hollow of the rail. This type of construction is described by Murray Alexander Stewart, Roadway Engineer, Toronto Department of Works, in a recent issue of The Canadian Engineer, to which we are indebted for the matter in this article.

In carrying out the construction of granite block track paving on a street where an old track allowance had existed before, the first procedure, according to present practice in Toronto, is to lay a temporary track at one side of the old structure, for such a length as may be convenient, connecting with the nearer old track by means of turn-outs.



Granite Block With 7-in. Girder Rail, 1915 Construction.

Prior to 1912 all reconstruction work was carried on while the cars were operating over the line, and it was therefore impossible to obtain the best results. In 1912 arrangements were made with the railway company whereby the city was allowed to build a temporary track, with turnouts at each end, on every job.

The traffic is turned onto the temporary track, and the section of the old track, which is thus relieved from traffic, is removed. The execavation for the new track is then made to a depth of 15 in. beneath the bottom of the rail, or, in the case of a 7-in. girder rail being used, to a depth of 22 in. below the grade. As soon as the sub-grade has been properly prepared, the new steel, ties and blocks are placed, the ties alternating with the beveled blocks at 4-ft. centers. After the rails have been securely spiked to the ties, the whole structure is blocked up and the rail properly lined and topped.

Concrete of 1:3:6 proportions is then placed for the entire width of a single track and one-half the width of the devil strip, for a depth of 9 in., the surface of the concrete being in contact with the bottom of the ties. After the concrete has set to some extent, but before it has thoroughly dried, the second course of concrete is placed and consists of filling in the spaces between the ties and blocks until level with the top of the ties. Before the placing of this second course, should it be evident that any shrinkage of the first course of concrete has taken place beneath the ties, the concrete adjoining the ties is thoroughly tamped in beneath them.

The next step in connection with the work is to place the filler strips, which consist of pine strips cut to the shape of the hollow of the rail and to convenient lengths. No portion of the strip projects beyond the head of the rail. These strips, before placing, are creosoted. After the strips have been placed, and the concrete foundation thoroughly set and sufficiently dried out to permit the work to be proceeded with, the cushion course is placed.

The latest work which we have done provides that this cushion shall be either of a dry mortar mixed in 1 to 4 proportions, or concrete consisting of 1:3:6 mixture, the stone constituent of which is ⅜-in. stone. Upon this cushion, which, if of mortar, must be dampened immediately, the granite blocks are laid and brought to a true surface by pounding, after which the grouting is immediately applied a sufficient number of times to insure that the joints are thoroughly full. The grouting consists of 1 to 1 mixture, and is mixed in an enclosed box and constantly agitated. It is applied to the pavement by means of scoop shovels.

The work is allowed to stand for at least two weeks before cars are permitted to operate over it. Then the other track is reconstructed, additional turn-outs being placed to divert traffic to the newly constructed track..

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## New Method for Sampling Boulder Deposits

A new method for sampling boulder aggregates in the field was described by L. Reinecke and K. A. Clark in a paper presented last week at the 21st annual meeting of the American Society of Testing Materials. The paper recorded a series of studies undertaken by the Department of Mines of Canada upon the variations in quality of deposits of road stone and gravel as they exist in the field.

It was found that boulder deposits in any one area consist of many combinations of three or four rock types of fairly uniform durability, and that the percentage of wear of any combination of the rock types found in deposits of boulder aggregates could be calculated by the following formula if the percentages of wear of each of the rock types were known:

$$W_m = \frac{\Sigma CW}{100},$$

in which $W_1, W_2 \ldots . W_n$ = percentages of wear of the various rock types, and $C_1, C_2 \ldots . C_n$ = percentage proportions in which the rock types are present in the combinations.

By sampling and testing the three or four types which make up a deposit, it is therefore possible to calculate the percentage of wear of any combination of these types. It is stated that an accurate estimate of the quality of boulder deposits of large size and extent can be arrived at by this method in a comparatively short time.

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**Speed Rule for West Virginia Highways.**—The Road Laws of West Virginia provide that no vehicle shall be driven on the highways at a greater rate of speed than will permit of bringing the vehicle to a full stop within half the actual sight distance at the place.

# Practical Hints on the Design, Construction and Repair of Asphalt Pavements*

By CHARLES A. MULLEN

[illegible]

**Asphalt Cement.**—The asphalt paving cement is, of course, a vital matter since we could not have an asphalt pavement without it. More pavements fail today, however, because of the lack of an understanding of the necessary requirements for the mineral aggregate, or carelessness or ignorance in the making of the paving mixture. Our public officials frequently go to great lengths to make sure that the materials furnished are what they should be, and then permit those materials to be spoiled at the asphalt mixing plant.

Many good asphalt cements are on the market. They are manufactured from crudes found in Mexico, California, Trinidad, Bermudes in Venezuela, and elsewhere. All are of so nearly equal value that only the uninformed or specially interested will today pay a great difference per square yard for asphalt pavement in which one or the other has been properly used. The per square yard competitive basis, under carefully drawn specifications and competent inspection, is now universally recognized in wholesome communities.

Asphalt cements need testing no matter from what crude materials they are made nor by whom. Some public officials do not seem to think so; but could they know how well they are spotted by the supply houses, and how carefully this frame of mind is cultivated for them, they would very soon change these views. Doubtful material, or material that has been condemned by some careful official who does have his deliveries tested, is always shipped to the other man.

The consistency or penetration of the asphalt paving cement is the first point to which we look. In a material that is pure, and with a mineral aggregate that is properly graded, it is customary to use the following classes of material for the different conditions of traffic in this climate:

| | | |
|---|---|---|
| Heavy traffic | [illegible] | penetration |
| Medium traffic | [illegible] | penetration |
| Light traffic | [illegible] | [illegible] |

Unless otherwise specified, all penetration tests are made with a No. 2 standard needle acting for 5 seconds under a load of 100 grams at 77° F.

The ductility and other tests are of great importance in determining the quality of the asphalt cement, but they are more particularly the concern of the asphalt chemist, and must receive close attention at the laboratory. The field engineer should be in close touch with the chemist and know the general characteristics of the asphalt cement he is using; but we will pass these points for the present to discuss others that are of more immediate importance to the greater number of us.

**Fluxed Asphalts.**—Fluxed or cut-back asphalts are so little used today that they no longer present a serious problem—at least, not in Canada. It is much easier to manufacture asphalt paving mixtures from cement that is delivered at the mixing plant at the desired consistency than when the cement must first be manufactured from crude or refined asphalt and flux oil. As a general proposition, the promiscuous cutting-back or fluxing of oil asphalts that have been refined to a hardness greater than that desired should be discouraged. While it is not necessarily harmful, and might even be beneficial, it is always at least a matter for close question. The native asphalts are naturally so hard that they require fluxing with some other suitable material before they are usable in asphalt paving at all, so the foregoing remarks do not refer to these materials.

Other filler materials are pulverized clay, marl, [illegible] Many substances have been tried and found satisfactory, but a few have produced disastrous results. [illegible] that a new material be thoroughly investigated before it is used extensively as an asphalt pavement filler. These investigations can only be conducted in a properly equipped laboratory, and by those with comparative experiences to draw upon.

**The Filler.**—The 200 mesh sieve is not a sufficient test for an inorganic dust filler, except for routine work on a known material. The particles of dust that are of the most value are those that would pass a 500 mesh sieve, were one of such fineness of practical value for laboratory testing.

Two hundred mesh fine sand was offered to the city of Montreal as a filler last season. A deposit of this material, practically all of which would pass the 200 mesh sieve, had been uncovered in a local sand pit; and it was tendered upon to the municipal purchasing department at a fancy sand price, as a substitute for the more expensive stone dust. It had to be rejected on the ground that, though it passed the specifications under which bids had been received, it was not a proper filler material at all, there being almost none of the finer particles for the separation of which no laboratory sieve is practical, and which are the really important factor in a dust filler.

**Photomicrograph Tests of Sand.**—Photomicrographs saved the day in this instance. It was a rather difficult matter to advice a city purchasing department that the material which passed their specifications better and was about 50 per cent cheaper than stone dust should not be bought and used; but, when we submitted comparative photomicographs of the part of each sample that had passed the 200-mesh sieve, and it was seen that the sand grains looked like rocks under the same magnification that still left the stone dust grains with the appearance of fine powder, even the low bidder, who was offering the fine sand, was satisfied that his material would not serve the purpose.

**Air vs. Water Separation Tests.**—The air separation dust test is, by far, the most satisfactory that we have yet found for making comparisons of fillers. Water separation gave some good results but the air method seems more practical. Neither is sufficiently simple to be used on routine work, so the 200-mesh sieve must still be relied upon for much of the checking of deliveries with samples submitted. As we do not know of any other air or water separators of the types we are using in Canada, they being constructed by us, it is hardly worth while at this time to base test requirements upon them.

**Careless Grading of Sand.**—The specially graded sand that forms about 75 per cent of the weight of a standard sheet asphalt pavement surface is a very simple matter, if one fully understands and appreciates what is necessary. To fully comprehend the very great difference in an asphalt pavement mixture that the grading of the sand will make, one has but to follow daily on the street the work turned out by a mixing plant where the man in charge is careless of detail, or thinks that any old sand grading is good enough.

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*From a paper presented [illegible]

We have seen a mixture produced by an asphalt paving plant at 1 o'clock that was all that could be desired, and at 4 o'clock of the same afternoon that plant was turning out, under the same formula of batch weights, a mixture that was not even third rate. The reason was that no attention was being paid to the sand. At 1 o'clock the supply was being drawn from a section of the pile that by chance happened to be of a very good grading, but by 4 o'clock the laborers had worked into a large pocket where the sand was very coarse.

The result of this carelessness was a poorly-graded, sloppy mixture, that could not be expected to give good service under heavy traffic, and that cost as much as the better mixture made earlier in the day. It will mark badly in warm weather, and probably shove, whether it has a binder course or not. The quantity of asphalt cement that is correct for a mixture having the standard grading of mineral aggregate is far too much for one in which the sand is coarse; but a plant crew that was not well enough organized and trained to watch the sand pile could not be expected to know when the proportion of asphalt cement should have been reduced to prevent a sloppy mixture.

**Proper Grades of Sand.**—Three grades of sand are needed in most cases to sufficiently approximate the standard or model sand grading. These may, for convenience, be termed fine, medium and coarse grade sands for asphalt paving purposes. · It will assist the layman to an understanding of the matter if we say that the fine is of that size which is sometimes spoken of as blow sand, the medium a good plasterer's sand, and the coarse a sand of the type we all recognize as suitable for portland cement concrete work.

One sand is occasionally found that is in itself a sufficient approximation of the standard grading, but such cases are rare, and, even then, it is a good precaution to have on hand small stocks of fine and coarse sands for tempering purposes in case the main supply does not at all times prove sufficiently uniform. Frequently a well-graded sand may be secured from a stratified deposit, by working the face to a certain depth that will take in layers the mixture of which, in falling and handling, will give a satisfactory approximation of the model. This we succeeded in doing with good effect last season at Woodstock, Ontario.

A fine sand for asphalt paving is one in which there is a decided predominance above the per cent required in the model grading of these sized grains that will pass a standard 80-mesh and be held on a standard 200-mesh sieve. The requirement of the model sand grading is 34 per cent of the total sand.

A medium sand for asphalt paving is one in which there is a decided predominance above the per cent required in the model grading of those sized grains that will pass a standard 40 mesh and be held on a standard 80-mesh sieve. The requirement of the model grading for medium sand is 43 per cent.

A coarse sand for asphalt paving is one in which there is a decided predominance above the per cent required in the model grading of those sized grains that will pass a standard ten mesh and he held on a standard 40-mesh sieve. The requirement of the model grading for coarse sand is 23 per cent.

Medium-fine and medium-coarse are the terms applied to sands in which there is a decided predominance above the per cents required in the model sand grading for two of the sand grades. This quite frequently occurs, and it is in such cases that the standard grading is sometimes sufficiently approximated by the mixing of two instead of three separate sands.

Very fine sand is objected to by many, on the ground that it usually makes an unstable mixture. In asphalt paving parlance, very fine sand is that which will pass a 200-mesh sieve, but which is not fine enough to be considered dust or filler material. With some of the very finely pulverized fillers that are available today we doubt if this objection is good.

Very fine sand is not filler, however, and it must not be allowed to be considered as such in meeting the standard or model grading for sheet asphalt paving mixture. If there is a serious amount of these 200-mesh grains in the sand aggregate, it should be added to the fine or passing-80-mesh-held-on-200-mesh material, and deducted from the 200-mesh material in the mixture, to make sure that the model requirement for 200-mesh material is properly met with true inorganic dust filler. Some specifications, very unfortunately, do not provide for this contingency.

Standard sand sieves are used in making screen analyses of asphalt paving aggregates, and not the commercial sieves that may be had on the open market at a low cost, though these may serve other purposes quite satisfactorily. Results on such commercial sieves are frequently as much as 20 per cent off, and these results are of no value to the engineer making asphalt paving mixtures. The 200-mesh, 100 and 80-mesh sieves are particularly troublesome, and should be frequently checked for accuracy.

**Mixing Sands.**—The mixing of three sands at the asphalt paving plant is not a difficult matter. At Saint Foy in Quebec, last season, where the Province was laying a stone-filled sheet aspalt pavement, we combined 5 grades of material in the mineral aggregate, exclusive of the filler, without difficulty. The various piles are arranged around the boot of the bucket elevator that feeds the heating drum, and then an intelligent laborer can be directed to feed so many shovels of this material and so many of that. A satisfactory result is secured in this way without additional expense, other than possibly 50 ct. a day extra to make the man doing the feeding interested in his job.

The sands for asphalt paving are to be found in almost every locality, if one will only look for them. We were told they were not to be had around Montreal, but a survey of the country for 50 miles about uncovered abundance, some in the very deposits from which the city has been getting its supply.

**Suggestions for Mixing Asphalt.**—The asphalt paving plant has never been more than a very crude machine at its best. Wherever possible, we are inclined to insist upon the standard type, especially the twin-plug mill mixer with a batch capacity of at least 1,000 lb. and means arranged above for proportioning the materials entering every batch by the weighing of such material separately.

The mixers should be covered to prevent the loss of the very finest particles of the inorganic dust filler —which are very valuable in the pavement and costly to buy—and so that the mixer platform may be a place where one does not hesitate to ask another human being to work. Most mixers are left uncovered, however, either because the owners do not appreciate the loss of material that is resulting, or do not care enough about the men who must work around them. It is time cities required covers on all mixers.

Steam-melted asphalt cement is never burned in the kettles. Therefore, direct firing should be avoided whenever possible, and watched with great care where not avoidable. Precautions should also be taken not to maintain the asphalt in a molten condition for too long a period, as this will cause it to become harder and lose some of its ductility.

Asphalt cement in tank cars should be arranged for whenever possible. The material may usually be had cheaper this way, and is easier to handle. If there is not sufficient storage capacity at the paving plant, a small quantity of the cement in iron drums should be kept on hand in case of the delay in transit of one of the tanks. Asphalt plants cannot afford to stop work during the busy season, for the overhead expense is too high.

Thoroughly mix the aggregate before pouring the asphalt cement into the mill. The practice of putting in the cement before or at the same time as the dust is dangerous. The sand is hot enough before being combined with the dust, so that after it has lost some of its heat to this cold material, the aggregate will still be of the desired temperature; and this original heat of the sand is too great for a thin filler of asphalt cement to stand without damage. If the mixer is covered, there will not be this tendency on the part of the mixer man to put in the asphalt cement first to keep the dust from flying into his face.

All temperatures at the plant should be watched with the greatest of care, and reasonable uniformity should be insisted upon. The purchase of a few thermometers, enough so that one may be placed at every point where it seems desirable, may save the loss of a very large investment in burnt asphalt movement. Even the most experienced workmen will sometimes overheat the materials.

The analyses of the mixture should approximate, as closely as possible in good practice, the following standard or model:

| Mineral Aggregate. Sieve Test |  | Model Asphalt Mixture |  | Model Sand Grading |  |
|---|---|---|---|---|---|
| Passing. | Held on | Per cent. | Per cent. | Per cent. | Per cent. |
| Bitumen ............... |  | 12 | 12 |  |  |
| 200 | mesh | 13 | 13 | Not over 5 |  |
| 100 | 200 | 13 | .. | 17 | .. |
| 80 | 100 | 13 | 26 | 17 | 34 |
| 50 | 80 | 23 | .. | 30 | .. |
| 40 | 50 | 10 | 33 | 13 | 43 |
| 30 | 40 | 8 | .. | 10 | .. |
| 20 | 30 | 5 | .. | 8 | .. |
| 10 | 20 | 3 | 16 | 5 | 23 |
| 8 | 10 | 0 | 0 | Not over 5 |  |
| Totals ............... |  | 100 | 100 | 100 | 100 |

The model sand grading is but the reduction to 100 per cent of the 75 per cent of the mixture model that is supplied by the sand aggregate free from dust filler.

An asphalt paving formula to produce the approximation of the foregoing mixture, with the usual materials, would be as follows:

| | | |
|---|---|---|
| Asphalt cement, pure bitumen.................. | 120 lb. | or 12% |
| Stone dust filler, [illegible] 200 mesh | 150 lb. | or 15% |
| Sand, [illegible] graded [illegible] | [illegible] lb. | or [illegible] |
| Batch of mixture.................................. | [illegible] | [illegible] |

**Hauling and Its Cost.** Canvas covers on the trucks are very good at all times, and especially in chilly weather when the crust of the mixture would otherwise become too stiff for proper raking. They should be so arranged that there is a 3 or 4 in. air space between the cover and the load, as this not only saves the cover, but also provides much better protection for the hot mixture.

One cent per inch yard mile is a good formula to remember when considering the cost of hauling asphalt paving mixtures. That is, it cost about 1 ct. to haul enough mixture to lay 1 sq. yd. of asphalt pavement 1 in. thick and weighing about 100 lb. on a street 1 mile from the mixing plant. Multiply 1 ct. by the thickness in inches of the pavement, and that by the number of miles between the plant and the job. This is a rough and ready rule that should not be used as a basis for a bidding estimate, but it will help in quickly considering the comparative advantages of various available plant sites. It was the basis of a large asphalt hauling contract in New York City at a time when team hire was $6 a day.

**Dumping Mixture.** The mixture should be dumped on the street on some spot outside of where any part of that particular load is to be laid, and all of it should be handled into place for raking by overturning the shovel at the place of deposit. Asphalt mixtures should not be cast long distances through the air to scatter over the foundation upon which they are to be placed. This is particularly true of those mixtures ranging from stone-filled sheet asphalt to bitulithic, in which such a casting about is likely to cause serious segregation.

Painting abutting surfaces of headers, curbs, manhole and catchbasin boxes, and so forth, is an old custom, and, we think, a very good one. The asphalt cement used for this purpose should be the same as that with which the mixture is made, and sufficient of it should be applied to be effective. If this detail of the work is worth doing at all, it is worth doing well, and not in the skimpy, careless way we so often witness on both contract and city work.

Sweep the foundation clean before placing the surface upon it. The investment is too great to be endangered by the neglect of a detail that costs so little. The roughened concrete surface that is preferred for asphalt paving requires some care in [illegible] to make certain that all the small depressions are reasonably free from dust and dirt and loose material.

**Suggestions on Laying the Asphalt.** Laying asphalt in the rain is not as serious a matter as one would at first suppose. Experience has demonstrated that sections of pavement laid during quite heavy rainfalls have lasted quite as well as other sections placed when the weather was more favorable. This is not a plea for selecting rainy weather to lay asphalt surfaces, but for the costly mixture that is frequently hauled to the dump because some inexperienced engineer thinks a little moisture from above during the laying will cause an asphalt pavement to fail. We do not recommend laying in puddles of water, however, and every possible precaution should be taken to avoid bad weather.

Leveling and paving mixture requires more skill and attention than it usually gets. The raking process should be a kneading into place with the tines of the rake, so that about the same weight of mixture will cover each square inch of the foundation. Only in this way can a pavement be laid that will get equal compression under the roller and that will be of equal density throughout. We believe that the depressions in asphalt surfaces are frequently due to the further compression under traffic of those parts of the pavement that are spanned by the wide wheels of the asphalt roller at the time of laying. Certainly a roller riding on two dense knobs of mixture cannot properly compress the loose material between.

A true surface is essential in any good paving job, but especially is this necessary with asphalt, where every little fault may be seen so easily. Also, if there are no waves, there can be no [illegible], and we often think that many surfaces displace partly because the original [illegible] left the beginning of the [illegible] condition that later became objectionable. A long straight edge, 10 ft. or more, constantly in use, will [illegible] for any paving job.

The straight line chart is used more extensively each year with all types of pavements, but it has special advantages in the case of asphalt where there is so much objection to the little shallow puddles of water that form on the center of other crowns directly following a rainstorm. The purpose of the crown is to shed water, and it should be made to do that as effectively as possible, with the least necessary drop from a horizontal line. One-quarter of an inch to the foot is sufficient where a straight-line crown is used and the surfacing work well done.

**Gutters Should Be Asphalt.**—Cutters should be asphalted to the curb. There is no reason for placing a cement or brick gutter on an asphalt street. Whether of asphalt, cement or brick, the gutter should rise at the rate of 1 in. to the foot or better, for the first 2 or 3 ft. from the curb, in order to form a decided dish that will confine the water in a narrow stream against the curbing instead of permitting it to spread several feet therefrom. If the same care had been used in forming asphalt gutters with the proper rise that was used in laying cement or brick gutters on asphalt streets, no one would ever have thought it necessary to employ the other materials. The flat asphalt gutters of early construction have much for which to answer. Proper gutters can be formed and compressed with a tamper, and an experienced roller man can get into them effectively.

**Stone or Brick Along Car Rails Not Necessary.**—Asphalt to the street and rail wherever the street railway roadbed is good. Where it is poor, compel the company to make it what it should be, if possible. There is something very disfiguring about a ribbon of blocks along an outer rail on an asphalted street, and it is absolutely unnecessary in most cases. The way in which the asphalt promoters have persuaded cities to lay block pavements along car rails on asphalted streets has always appealed to me as diabolically clever. These men know that whatever is laid will go to pieces where he rail construction is bad, and, by shunting it over upon the other material, they avoid the discredit that would unavoidably, though unjustly, fall upon asphalt.

**Maintenance of Asphalt Pavements.**—First construct then maintain your asphalt pavements. They should not require any repairs for a number of years after laying, except where some defect in construction comes to light; but, whatever they do need, they should get. Repairs should be carefully made, with perpendicular edges and properly painted joints. An asphalt patch should not be higher than the surrounding surface. If properly compressed in the making, there will be no shrinkage under traffic that will require an allowance. Do not leave the surface higher than the car rails, manhole boxes, and so forth, against which it is laid. This has been tried and abandoned.

Three methods of mainteance for asphalt pavement surfaces should be considered. There is the simplest way, the cutting out of the defective section and replacing it with new mixture; the surface burner method has been used extensively, with fair results; and the remelting and remixing process has been successfully employed in many places. Needless to say, all three methods can be used to advantage in every large city, each being fitted to different conditions that are sure to confront the engineer.

The remelting and remixing of the old surfaces has always seemed to the author the one way that should be more carefully developed, with a view to the future maintenance of our asphalted streets. The re-use of the old material, which can be made as good as ever at little cost by remelting and remixing, with possibly a little added soft asphalt to rejuvenate it, will effect great economies in pavement maintenance over a period of years. The cost of new material is saved, and the expense of hauling the old surface to a dump is avoided. The trucks must return to the mixing plant anyway, and they may as well carry a load of old asphalt surface as go back empty for the next load of mixture.

**Asphalt Is in Its Infancy.**—Asphalt is in its infancy as a paving material. Each year sees larger tonnages of it used for this purpose, and, as paving economy is more carefully studied by our public authorities, the very clear reasons for its extensive employment as a road surfacing material will be fully appreciated. The more universally it is used in any city, the more economically it can be handled.

## Federal Council to Control Road Work

All functions of Government agencies relating to streets and highways have been co-ordinated in a body called the United States Highways Council, composed of one representative each from the War Department, the Department of Agriculture, the United States Railroad Administration, the War Industries Board, and the Fuel Administration. The council was formed primarily to prevent delays, financial loss, and uncertainty incident to the method of taking up each highway problem in its turn with a separate and distinct Government agency. This council was constituted at the suggestion of the Secretary of Agriculture. Through the Department it will continue the close contact already established, both formally by law and informally by practice, with the State Highway Commission in each state of the Union.

Membership of the Board follows: War Department, Lieut. Col. W. D. Uhler; Fuel Administration, C. G. Sheffield; War Industries Board, Richard L. Humphrey; Railroad Administration, G. W. Kirtley; Department of Agriculture, L. W. Page. These representatives have selected Logan Waller Page, Director of the Office of Public Roads, Department of Agriculture, as chairman, and J. E. Pennybacker, Chief of Management of that office, as secretary.

The council utilizes the organizations of the 48 state highway departments with their trained personnel and their knowledge of local conditions and provides a single agency where all highway projects calling for governmental action of any character, whether it be a question of finance, of materials, transportation, or of war necessity or desirability, may be dealt with. The council has provided a definite form on which applications for relief are to be made through the respective state highway departments, and has sent supplies of the forms to the departments. The Council emphasizes the great need of conservation of money, transportation, labor and materials by restricting highway and street work to most essential needs. It ranks maintenance of existing streets and highways first, reconstruction of badly damaged streets and highways next, and it places last new construction justified only on account of vital war or economic necessity.

**State Road Work in North Dakota.**—The State Highway Commission is calling for bids on four contracts for earth road construction covering approximately 50 miles of highway.

# The Evolution of Foundations for Street Car Pavements and Tracks

An interesting outline of the development of street car track paving at Toronto, Ont., was given by Murray Alexander Stewart, Roadway Engineer of the Toronto Department of Works, in a recent issue of The Canadian Engineer. The matter following is abstracted from the above mentioned Journal.

In the early days of the street railway company's franchise, the necessity for what is now known as a permanent pavement was not so urgent as it is at the present time, and types of pavement, the laying of which has long since ceased, were permitted. This is particularly so in the case of cedar block, of which a great deal was laid in the past.

The greatest development, however, has taken place in the foundation supporting the pavement. The early types provided for a course of gravel beneath the ties and concrete between the ties, the pavement being placed upon the ties and concrete. It will readily be seen that such a structure, permitting as it did a great deal of movement of the rail, promoted very rapid deterioration of the pavement.

In 1893, after the subgrade had been prepared, a trench, 12 in. deep below the bottom of tie, was made down the center of the excavation and two rows of 2-in. tile drain placed. This trench was then filled with gravel, as was also the entire excavation, to a depth of 4 in. Upon this gravel the ties were placed at 3-ft. centers and the rails spiked thereto. The spaces between the ties were then filled with concrete, which was also carried around the ends of the ties to the outside edges of the track allowance area. Inasmuch as the ties were 6 in. in depth, the concrete was the same, with the addition of as much more on top as was necessary to insure a 1-in. cushion of sand beneath the bricks which constituted the surface of the pavement.

Immediately before laying the surface, the sand cushion was struck to a true surface with a template, and the hollow of the rail filled with a very stiff cement mortar. This was so finished as to present a perpendicular face, which dropped from the outside points of the head of the rail. The laying of the pavement was at once proceeded with, a row of scoria blocks being first laid as stretchers, or in some cases alternately as header and stretcher, and the bricks then laid in courses, at right angles to the line of the work. The bricks were then grouted in the usual way. Other materials, such as cedar block, asphalt block and stone block, were used on various works, but the above serves to illustrate the general practice at that time.

This method of construction in time proved very unsatisfactory, and in 1895 a radical change was made in the foundation, although the same methods obtained with respect to the surface. Instead of placing ties at 3-ft. centers and filling between with concrete, no ties were used and a concrete base was placed for the entire area of the track allowance. This base was 8 in. in thickness for a width of 10 in. on each side of the center line of each rail and 6 in. in thickness in the center. This type of foundation was found to be inadequate, and it was thought that there was not sufficient weight of concrete beneath the rails. For that reason, in 1905 the foundation was changed to the extent of making that portion which lay beneath each rail 12 in. in depth instead of 8 in., otherwise the dimensions were the same. The laying of the pavement, was carried out as has been described in the article on granite pavements.

In 1906 the track paving was widened so that the width of strip between the tracks became 5 ft. 4 in. instead of 3 ft. 10 in. This was done in order to permit the operation of wider cars. The types of pavement, however, which were available for work of this character were reduced considerably, and practically all the work laid at this time and for some years after consisted of granite block, vitrified brick and scoria block.

About this time a considerable amount of T-rail was used, which altered to some extent the method formerly adopted in paving. It was impossible, of course, to lay the pavement directly against the head of the rail as heretofore, as provision had to be made for the flanges of the car wheels. To this end, what were known as half-and-whole flange blocks were used, and were laid alternately in order that a proper bond might be made with the balance of the pavement.

These blocks, which consisted of either granite or scoria (molded slag block), were similar to the ordinary rectangular blocks, with the exception that one corner for the full width of the block was cut out for a sufficient depth and width to permit the small end thus created to be placed beneath the head of the rail and lie solidly against the web. In this way a groove was established for the accommodation of the wheel flange. The blocks were bedded in 1:4 cement mortar, and the mortar casing used with the girder type of rail was done away with. It may be added, however, that the use of the T-rail has for the last few years been abandoned.

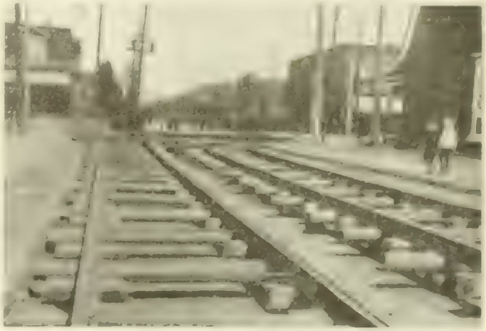

Fig. 1—Type of Structure Used on All Work Since 1911. Ties and Bevelled Blocks Alternately Spaced at 2 Ft. Centers

The foundation just described, in turn developed certain weaknesses, and was replaced in 1911 by a slab, 12 in. in thickness, for the entire width of the track paving area.

The use of ties was also resumed, as it was found that upon those tracks where no ties had been used great difficulty was experienced in keeping the rails in proper alignment and to proper grade. At this time steel ties were first discussed, and they were tried out on certain works, being placed at 6-ft. centers and secured to the rail by means of clips, bolted to the ties and overlapping the base of the rail.

Another alteration took place last year on certain track, built in the most heavily traveled parts of the city, the foundation being increased to 15 in. of concrete on straight track and 18 in. beneath all intersections. This foundation was laid in two courses, the first course being 9 in. in depth and the top coming into contact with the bottom of the tie. After the concrete had set, but before it had thoroughly dried, the second course of 6 in. was placed, the concrete of the first course being thoroughly pounded beneath the ties and any apparent shrinkage taken up by floating in a cement grout.

The use of steel ties was also abandoned on this later work, as difficulty was experienced in holding the rails securely with the clips and in making repairs, and wooden ties and beveled wooden blocks, alternately spaced at 2-ft. centers, as shown in Fig. 1, were again introduced. This foundation has been in use on all work since 1911, and at the present time there is, so far as can be seen from the excellent results obtained, no occasion for alteration.

## Township Road Maintenance in Illinois

By B. H. PIEPMEIER,

Maintenance Engineer, Illinois State Highway Department.

Illinois has about 95,000 miles of public highways, of which less than 12 per cent have been improved. Approximately 1 per cent of the improved roads have been constructed of brick, concrete or bituminous concrete. The majority of the improved township roads have been constructed of gravel or crushed stone, with little attention paid to drainage, materials used or recognized standards of construction. Many of the so-called gravel roads should be classed as sand-clay roads. The majority of the macadam roads that have been constructed do not deserve the name and should be classed merely as stone roads.

During 1917 township officials spent approximately $8,000,000 in the construction and maintenance of township roads and bridges. It is estimated that at least 50 per cent, or $4,000,000, was spent in the construction of bridges. It is further estimated that about $1,000,000 was spent in the construction of hard surface roads and another $1,000,000 in supervision and overhead. There was left, therefore, a balance of $2,000,000, or $21 per mile, that was used in the maintenance of all types of roads. This deficiency in maintenance funds is the chief reason why Illinois has a great many very bad roads and why it ranks so low among the states in improved roads.

Experience has shown that it is much easier to maintain all types of road after they have been properly constructed and drained. A great many of the improved roads of Illinois have not been properly graded and drained. The maintenance expense on the average township road, therefore, is unnecessarily high and the results obtained in many cases unsatisfactory.

On all state aid roads in 1917 the expense of cutting weeds, dragging side roads, cleaning ditches, etc., known as "upkeep," amounted to $51 per mile of road. The "upkeep" cost was approximately the same for all types of roads. The expense of maintaining the wearing surface or traveled way was the greatest variable, as this part of the expense depended upon the type of road and traffic.

If it requires $51 per mile for the upkeep on highly improved roads, it is readily seen that $21 per mile is entirely inadequate for the maintenance and upkeep on the average unimproved township road.

The answer is that more money must be provided to meet the expense of maintenance and upkeep on all roads, thereby insuring better service to the increasing traffic.

## The Massachusetts "Cost Plus Profit" Road Contract

Last season the Massachusetts Highway Commission, of which Mr. A. W. Dean is Chief Engineer, employed a "cost plus" form of contract on some of its state road work. The plan worked very successfully and is being continued this year.

Under the contract the state furnished all material, paid the actual cost of labor and teaming, and paid the contractor rental for his machinery. Extracts from a contract awarded in May, 1917, for building sections of a macadam road in the towns of Dalton and Windsor will give an idea of the cost plus profit form. It is stated that the contract form for 1918 has been modified slightly, further reducing the risk to the contractor. Under the heading "Work to Be Done" the above contract provided:

The contractor shall do such grading and surfacing as the engineer may direct, shall construct such waterways, culverts, bridges, guard rails, or other structures and shall perform such other work as may be directed by the engineer.

Section 2a. The contractor shall furnish all labor, workmen and mechanics and all teams required for the proper performance of said work; also all small tools and appliances, such as lanterns, rubber boots, shovels, picks, axes, hammers, drills, bars, wheel-barrows, plows, harrows and tools and appliances of like character.

Section 2b. The contractor shall also furnish all machinery required, such as concrete mixers, steam shovels, road rollers, graders, etc.

Section 2c. The commission shall furnish all material, such as broken stone, cement, pipes, etc., all materials so furnished to be the property of the commonwealth.

Section 2d. The contractor shall insure at his own expense in accordance with the provisions of the Workmen's Compensation Act, all of the laborers, workmen and mechanics in his employ who may be engaged in the work herein contemplated.

The provisions for payment by the state for labor and rental of machinery were as follows:

For all labor and teaming the actual cost thereof to the contractor as shown by his paid pay rolls approved by the timekeeper employed by the commission, provided, however, that the amounts to be paid to said contractor under this item shall not exceed the following sums:

| | |
|---|---|
| For laborers | $3.00 per day |
| For double teams and drivers | 5.00 per day |
| For foreman | 6.00 per day |
| For superintendent | 7.00 per day |

No allowance to be made to said contractor for or on account of the purchase or use of such tools, appliances as are furnished by him under the provision of Section 2a of this contract.

For the use of a steam shovel, while necessarily on the site of the work, $20 per day.

For the use of a grader, while necessarily on the site of the work, $15 per day.

For the use of a steam roller, 6 ct. per lineal foot for all roadway rolled.

For the use of air compressor, drill outfits, while necessarily on the site of the work, $3 per day.

For the use of crusher, bins, screen, etc., while necessarily on the site of the work, $8 per day.

No increase in the above allowance shall be made except with the written consent of the commission.

The unit bidding prices on this particular job and the estimated quantities bid on were as follows:

| | Quantities. | Unit bid. |
|---|---|---|
| Excavation or embankment, except ledge | 26,000 cu. yd. | $0.05 |
| Borrow | 2,000 cu. yd. | .05 |
| Ledge excavation | 400 cu. yd. | .10 |
| Concrete masonry and use of mixer, 1:2½:5 | 320 cu. yd. | .60 |
| Broken stone rolled in place | 7,600 tons | .10 |
| Iron water pipe, 12 in. | 60 lin. ft. | .05 |
| Iron water pipe, 18 in. | 70 lin. ft. | .05 |
| Corr. iron pipe, 12 in. | 650 lin. ft. | .02 |
| Corr. iron pipe, 18 in. | 300 lin. ft. | .02 |
| Fencing, standard guard rail | 400 lin. ft. | .02 |
| Stone filling | 14,600 cu. yd. | .07 |
| Grubbing and clearing | 9 acres | 13.00 |
| Rock embankments | 60 cu. yd. | .14 |
| Concrete masonry and use of mixer, 1:2:4 | 40 cu. yd. | .60 |
| Rustic fencing | 2,600 lin. ft. | .02 |

It should be stated that on this contract the above profit prices were bid extremely low as the contractor expected to make money out of his commissary.

# Road Building at the Front

One of the most interesting addresses delivered at the recent 5th Canadian Good Roads Congress was that of Lt. Col. William G. Mac Kendrick, Director of Roads, Fifth British Army. In his address, quotations from which are given below, Col. Mac Kendrick described his experiences in road building for the Canadian and English armies in France.

"My first job of road building in France was for the Canadians. I was put in charge of 1,000 Belgian refugees—civilians—who were paid 4 francs each per day for working on the roads. These men had to walk from 7 to 12 miles per day before they reached their work, and then walk that distance back home again in the evening. Was it any wonder that they had no energy left for their work? Motor lorries were employed to collect workmen, and within a month the work showed very satisfactory results.

"These Belgians were divided into 32 gangs, with a foreman for each gang. At the end of the month, the paymaster handed in cash to each foreman the pay for his gang without any check whatever upon whether the cash reached its ultimate destination, and without any check on the number of men employed or the hours which they worked. These methods were changed and soldiers appointed as time-keepers, thus saving something like 30,000 francs per month in the pay roll by cutting out the loafers, etc.

"Moreover, modern methods of handling these men greatly increased their output. Six gangs working in the woods getting out defense pickets, posts and other timber, trebled their output. Ten gangs in the quarries getting out stone also trbled their output. The other 16 gangs were on the actual road making, and their output was doubled. The Belgians, when given proper superintendence, make excellent workmen.

"Before the war the French roads were in good repair, but they were greatly overworked, even the routes Nationale. The heavy guns ground the stone to powder and the roads went to pieces fast, especially in the spring and fall.

"In 1916 was sent to the Somme to make roads for the Fifth British Army. There were 250 miles of broken-down roads that they had been fighting over for months. The stuffing of these roads was gone, and they wanted them re-built so that they could fight over them again within three months. The center of the road was often a ditch holding water and mud from 8 to 10 in. deep, of the consistency of pea soup."

"We gathered all the officers of the various corps and told them what we wanted done; nevertheless, we could not get sufficient stone. But for 5 miles of the road leading out from Acheux, we picked the stone off the outer 6 ft. of each side of the road and threw it to the inner 6 ft., so that we had 12 ft. of fairly good road in the middle. Later the director of roads gave us four and five times the quantity of stone we had before, and timber as required, so we never lacked material to work with after he took charge."

"When 'the big push' was on we could not get stone. As a result we canvassed the surrounding country for everything that could be put onto the roads. Consequently, there are many villages of which not a single brick, stick or stone is left. We took the bricks from the houses and from the ruins and put them on the roads. We carted the stones from the broken walls. The army, as they advanced, used all the wood for fires to cook their meals, etc. We used the larger timbers, roof-rafters, etc., to fill up shell holes and to plank muddy places. It is a fact, therefore, that of many villages there is not a trace, virtually not one stone being left on top of another. One village of 2,000 inhabitants, that I have in mind, has disappeared absolutely with the exception of a piece of granite block which was laid where the center of the village had been.

"The road north from Albert to Bapaume was for a time the only line of communication to the British front, and everything that went up to the army traveled over that road. It was built of 4 in. of gravel on sand foundation on clay. The caterpillars, weighing 17 tons, shook it to pieces with their incessant pounding. We had previously had 300 motor lorries on our road work, but they had taken away all but 23, and I had a strenuous time getting 200 more and stone to fix that road, but we finally got it rebuilt and in splendid condition.

"Altogether, I had 764¾ miles of army roads under my care at that time. Besides the motor lorries, we had about 300 general service wagons, 56 road rollers and 12,000 men.

"Many of these roads were blown to pieces by the Germans. When I first went to Flanders I saw that planks were the only thing that would save the situation, but I could not get the planks. A plank road costs less, and can be built 20 times as fast, and over some kinds of ground will carry traffic that stone will not carry. The shell holes on some of the roads were from 5 ft. to 15 ft. in diameter. When it rained for a week, as it would, these holes would fill with water and stay full. I pointed out how impossible it was to build macadam roads under these circumstances, and asked for planks. When the new transportation department, under Major-General Sir Eric Geddes, got to work, they secured millions of railway sleepers for road building; also 3-in. planks, which were used by all the armies in their advances on the western front. Sir Douglas Haig, in his despatches since then, has told of the value of those plank roads to the British army. At Vimy Ridge, Passchendaele and Messines, he said, the army could not possibly have advanced without them.

"We found the method of building a Telford road in France, putting the stone on edge and then using small stone on top, did not carry the heavy lorry traffic. Even 20 or 30 in. of stone so placed did not hold the road up in place. We, therefore, changed the method and laid stones on their flattest side, then filled in 4-in. stone on top for a total depth of 9 in., putting a good crown on the stone and rolling where possible. Under these methods, we found that we were getting much better roads for one-third the cost, and that our roads wuold carry the heaviest kind of motor traffic.

"The stone was mostly a soft limestone. In six weeks even 6 in. of this stone would be ground to powder and blown away. We found that 4, 5 and 6-in. stone were the best sizes to carry the motor traffic for soft spots. The 2-in. stone would 'mush up' in wet weather, having too small a base and not enough bearing power to carry the traffic.

"At Verdun the French road builders undoubtedly saved the day. The Germans had totally interrupted their railway transportation on what was then the only railroad leading up to the French front at that point. A French road engineer organized regular schedules of motor freight trains. The trains left at definite intervals, just as on a railroad, and ran to schedule. If a motor broke down or was delayed, it was shoved to the side of the road. In this way supplies of materials of all sorts were kept up for three months, and this was undoubtedly the saving of Verdun, and thereby the saving of Paris."

## War Time Policy in Road Building

The following statement was issued last week by the U. S. Department of Agriculture:

Governmental agencies dealing with highway problems fully recognize the vital military and economic importance of the country's roads, according to a letter from Secretary of Agriculture Houston to Arthur H. Fleming, Chief of the State Councils Section, Council of National Defense.

The secretary, whose department administers the Federal Aid Road Act, stated also that the Government recognizes that it is necessary to construct, reconstruct or maintain roads essential for military and vital economic purposes and to defer action on roads not of this class; and that it is desirable, wherever possible, to use local materials for road building and maintenance in order to relieve railroad traffic.

Important highways, as described in the secretary's letter, include only those utilized, or to be utilized, by the military establishment, those which carry a considerable volume of materials and supplies essential to war industries, and those which have a bearing on the production and distribution of food supplies, connecting population and shipping centers with surrounding agricultural areas.

**Duties of Highway Council.**—Attention is called to the formation of the United States Highway Council. This body was suggested by the secretary to co-ordinate Federal agencies interested in highway problems. The council is made up of a representative each from the Department of Agriculture, the War Department, the Railroad Administration, the Fuel Administration and the War Industries Boards. It will form a unified agency for dealing, on behalf of the Federal Government, with highway construction, maintenance and policies. It will, of course, through the Office of Public Roads and Rural Engineering of the Department, continue the close contact already established, both formally by law and informally by practice, with the state highway commission in each state.

The Office of Public Roads and Rural Engineering and the Highways Council will actively consider the supply, for highway purposes, of road oils, asphalts and other bituminous road materials controlled by the Fuel Administration, and the matter of priority production for highway materials controlled by the War Industries Board. They will also, in contact with the Railroad Administration, aid in securing, so far as practicable, facilities for the transportation of road materials and supplies. Furthermore, the Office of Public Roads and Rural Engineering will act as the medium for furnishing information and assistance on highway problems, especially to state highway authorities in meeting the various difficulties which they encounter.

**Work Planned Before War.**—When the United States States entered the war the work of planning state highway systems, so that, as far as necessary and feasible, they would connect with the systems of other states, was well under way. This resulted from efforts to administer the Federal Aid Road Act, so that the roads of vital importance for economic, military and other purposes should first be dealt with. The Federal Aid Road Act—involving an aggregate 5-year expenditure, directly and from state and local funds, of $160,000,000 in addition to at least $200,000,000 spent independently each year by the states—provides that the states must maintain the roads and that before any money can be expended the roads must be selected and approved and plans, specifications and contracts submitted. It also provides that the Federal Government must inspect the construction of the roads.

**War Road Policy Adopted.**—Soon after the United States entered the war, the Department of Agriculture requested the State Highway Commissions to join it in directing expenditures only on roads of prime importance for economic and military purposes. In this undertaking, the secretary says, the department has received the co-operation of state authorities.

The department has been actively co-operating with the Capital Issues Committee in its task of keeping out of the market road bonds the issuance of which was not urgent from the point of view of aiding the nation in winning the war.

The secretary also calls attention to the fact that road engineers have been provided by the department for each of the army cantonments and for work on roads elsewhere in which military authorities were interested.

## Maintenance and Repair Costs of Connecticut Roads Doubled in Last Four Years

Expenditures for ordinary maintenance and permanent repairs of trunk line roads in charge of the State Highway Department of Connecticut have nearly doubled during the past 4 years. The figures for the 4 years, according to the annual report of Charles J. Bennett, State Highway Commission, for the year ending Sept. 30, 1917, are as follows:

| | Miles maintained. | Ordinary maintenance. | Permanent repairs. |
|---|---|---|---|
| 1913-14 | 744.57 | $587,182 | $197,917 |
| 1914-15 | 906.92 | 666,762 | 214,175 |
| 1915-16 | 915.76 | 567,130 | 414,479 |
| 1916-17 | 923.43 | 709,420 | 786,067 |

The above figures do not include the cost of supervision and equipment. The item permanent repairs covers the placing of hard pavements on roads already constructed. The item "ordinary maintenance" also covers the cost of oiling state aid roads, the mileage of which is not included in the above figures. The cost of oiling for 1916-1917 was $87,112. The average unit cost of maintenance and permanent repairs on the 923.43 miles of truck line roads for the year Oct. 1, 1916, to Sept. 30, 1917, was as follows:

| | Per mile. |
|---|---|
| Repairs | $ 91.72 |
| Maintenance | 579.78 |
| Permanent repairs | 861.25 |

**Effect of Tractive Resistance on Cost of Hauling.**—Tests were made recently by the Packard Motor Car Co. to determine the relative values of different roads as regards resistance to tractive efforts. It was found that unsurfaced concrete offered a resistance of 30 lb. to the ton, surfaced concrete 50 lb., gravel 82 lb. and dirt roads 99 lb. The experiment was performed with a Packard 3-ton truck carrying a capacity load and operating at a speed of 12 miles an hour. Taking the unsurfaced concrete as standard, the truck will make 7.2 miles per hour over surfaced concrete, 4.8 miles per hour over gravel and 3.6 miles per hour over dirt roads. This makes a relative cost of $0.167, $0.194, $0.207 per ton-mile in the last three instances.

# Oiling Macadam Streets*

**Sweeping Off the Dust.**—On country stone roads, where frequently the dust lies inches deep in layers, a horse sweeper could be used with great benefit and at very little added expense to remove this surface material to the side of the road, where it could be taken care of by different means, depending upon the environment. I have in mind many country roads where, regardless of the character of the surface of the road and the amount of dust and loose material on the road, the oil cart goes along and sprinkles the sand. It is only a short time before that oil dust is blowing with every vehicle that passes, making the actual dust conditions much more disagreeable than the ordinary dry state of the dust. Oiling performed after cleaning is much more effective, and I am of the opinion that the results warrant the small additional expense of such cleaning.

**Selecting the Oil.**—Having prepared the road surface, the next consideration is the character of the material which is to be used and the method of its application.

Asphaltic petroleums and tar products are the most common materials used for this purpose. Until recently they have been easily obtainable. They lend themselves readily to distribute, and prior to war prices were an economic material for this purpose.

The asphalt petroleum is sold commercially as a 40 per cent, 60 per cent and 80 per cent asphaltic oil, increasing in specific gravity in the order named. The tar products are sold under trade names which indicate varying degrees of specific gravity, the purchaser purchasing that particular product which is most suitable for his requirements.

Our experience in Hamilton has proved that what is known as a "light road oil" or a "medium road oil" for city work may be used with great effectiveness. In some cities a considerable lighter oil is used than the "light road oil," but this requires a more frequent application with a consequent increased cost.

Ordinarily, except under very heavy traffic, one application per season has been found to be sufficient of the 40 per cent and 60 per cent asphaltic petroleum. The lighter grades of oil may, however, be applied earlier in the season and without the necessity of heating in order to facilitate distribution. They are easily absorbed, dry out more quickly and reduce the dust nuisance during the late spring and early summer months. Light oils are applied also in smaller quantities than the heavier oils, as low as .085 gal. per square yard being found sufficient for good results. This is a very low figure. It is the Toronto figure. It is necessary to go over these roads two or three times a year, but they do away with that sticky condition which obtains in the use of heavier oils.

**Road Surface Should Be Warm and Dry.**—Much better results are obtained if the road surface is warm when the oil is applied, as diffusion through and over the surface then readily takes place before the oil congeals. This is especially applicable to the heavier bituminous materials. The surface should be free from moisture.

I was going to put it stronger and say it "must" be free from moisture. We have, however, been caught out in a rainstorm with a cart full of oil, and continued work. If the sun came out and dried things up quickly, it was not so bad. But we have had difficulty where the oiling was performed on damp surfaces, in getting proper drying and penetrating effect.

**Applying the Oil.**—Heat is usually necessary in the application of the heavier road oils. In Hamilton, where last year and this year we are using a medium asphalt road oil; i. e., an asphaltic oil which under certain conditions of test contains an average of 06 per cent of the original asphaltic petroleum, the oil is first heated in large steel tanks by steam coils to a temperature of from 100 to 150°, and pumped into ordinary oil carts, from which the oil is distributed by gravity on to the street.

The method of procedure is as follows: The street is first thoroughly swept by horse brooms and all the loose material that is practicable is cleaned from the surface of the street and removed. Oil, while hot, is then applied by a gravity sprinkler at the average rate of 1/8 gal. per square yard of road surface. Coarse rock screenings and stone dust are then distributed by hand over the surface of the oiled road in order more quickly to absorb the oil and prepare the road to receive traffic.

In calculating that figure of 1/8 gal. per square yard of road surface, we measured the road from curb to curb. The sprinkler does not sprinkle the whole width of the street, but the whole width is effectively oiled, in that a certain amount of the oil runs down the crown and effectively oils the portion next to the curb, so that I feel it is right and fair to consider that the whole road surface is oiled.

Ordinarily the street is not closed to traffic. Better results would be obtained here if the streets were closed from 24 to 36 hours after the oil application, in order to allow a certain amount of absorption and hardening of the oil to take place before traffic is allowed on the street. On busy city streets, however, this is hardly practicable. When we are oiling up one street and down another, we would have a large section of the city completely ostracized from the rest of the town except by pedestrian traffic, and this would cause great inconvenience. We find it does not cause really serious difficulty to let the traffic go right over the street after it is oiled.

The amount of oil used depends altogether upon the character of the surface being treated and the extent of the coating desired. It varies from 1/8 to 1/4 gal., and sometimes 1/2 gal. per square yard.

**The Cost of Oiling.**—The average cost at Hamilton last year, without regard to overhead such as superintendence, engineering, repairs to plant, depreciation, insurance, etc., was $.01673 per square yard, or $1.673 per 100 sq. yd. This is equivalent to $235 per mile of 24-ft. roadway, or a little less than 2 1/4 ct. per lineal foot of frontage.

I was surprised when we began to figure up our overhead in connection with our road oiling proposition. Our repairs to our little pump at the yard where we have our tanks, the cost of steaming, heating, the repairs to our tank, the depreciation, insurance, etc., amounted to 31 per cent of our total cost. I went into that very carefully. I was thunderstruck, but that is what keeping costs tells us.

Ordinarily, unless costs are very carefully analyzed, and a knowledge of conditions obtained, the figures are apt to be misleading rather than instructive. They vary, depending upon the price of labor, material and the methods adopted, so that real efficiency must be judged on a basis of these considerations.

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*From a paper presented [illegible] Engineer, Hamilton, Ont.

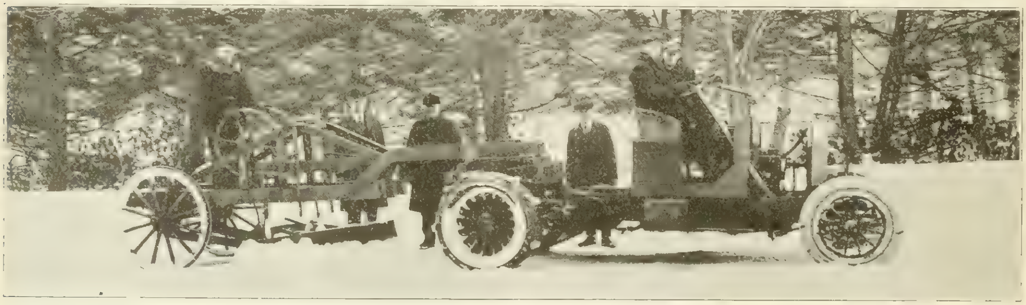
The following base prices were applicable to the above costs:

| | |
|---|---|
| Teams per hour | $0.75 |
| Labor per hour | .35 |
| Oil per gallon | .096 |
| Screenings per ton | .85 |

The screenings were distributed by shovel from a wagon traveling slowly along the street.

## Road Machine Drawn by Tractor Used for Snow Removal

A road machine hauled by a tractor was employed last winter by the Street Department of Worcester, Mass., in snow removal work. An old Champion road machine was attached by a goose neck to a Knox tractor, as shown in the accompanying illustration. The outfit was used both for smoothing up streets where the automobile traffic had deeply rutted the snow surfaces, and for the purpose of pushing aside surplus snow so as to give a motor traffic roadway wide enough for two trucks to pass. The outfit proved particularly effective for plowing out gutters to get a proper flow of the water. The road machine-tractor unit was very flexible and gave far better results than had been obtained from the horse-drawn machines which had been used previously. During the next winter it is planned to put the machine in operation on downtown streets late in the evening, when traffic has left the street, throwing the material back from the center and ridging it up toward the gutter for carting away by teams and trucks on the following day.



Road Machine Was Reconstructed in the Head End so as to be Drawn by Tractor.

We are indebted to Mr. J. C. Blake, Street Commissioner of Worcester, for the matter in this article.

## Testing Laboratories Should Collect Their Own Field Samples

In a discussion of the special report of the Am. Soc. C. E. committee on road materials, Mr. J. O. Preston suggests that the only safe procedure for sampling highway materials is to have trained men in the laboratory for the purpose of going into the field and collecting all samples. He believes that it will prove ultimate economy for state or municipal laboratories (and all other large-scale organizations) if, instead of awaiting samples to be sent in for test, they develop an organization to collect them. This organization would prove of great value in many other ways; not only would laboratory control be more complete, but field inspectors could be instructed in the proper use of materials. (Engineers seldom have time for sufficient instruction in the field.) The slight additional cost would be cheap insurance; it would aid both the engineer and the contractor to obtain better materials and prevent their misuse or adulteration.

## 5,000,000 Motor Cars in United States

A total of 4,983,340 motor cars, including commercial vehicles, were registered in the United States in 1917, according to the Management Branch of the U. S. Office of Public Roads and Rural Engineering.

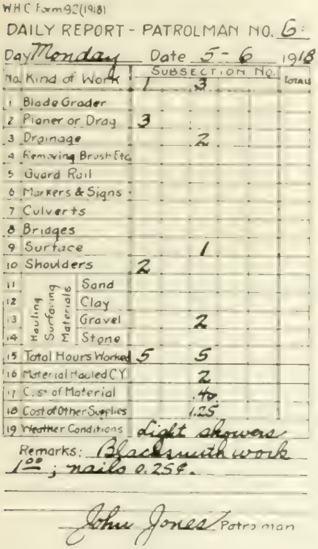
The sum of $37,501,237 was collected in registration and license fees, including those of chauffeurs, operators, and dealers. As compared with 1916 this represents an increase of 1,470,344, or 44 per cent, in the number of cars and $11,637,867, or 45 per cent in revenues. Approximately this same rate of increase over each preceding year has continued during the past 5 years. There is as yet no indication that either the curve for motor cars or that for the motor-vehicle registration revenues is approaching a maximum or has even reached the saturation point.

There is very little definite information available as to the number of motor cars in countries other than the United States. According to the best available data and estimate, however, about 85 per cent of all the motor cars at present in existence are in the United States. About 200,000 cars are in Canada, in all Provinces of which annual registrations now are in force. Probably 50,000 cars are found in all the rest of North and South America. The present number of cars in Europe is not known with any degree of accuracy. Estimates based on data available for 1914 would place the total number below 500,000, or about the same as the number of motor cars existing in the two states of New York and Connecticut. Thus, according to the best available data, nearly 90 per cent of all existing motor cars are in North and South America and about 10 per cent in all the rest of the world.

In 1906 the total state registrations were approximately 48,000 cars, or less than one-hundredth of the present number and the revenues collected in the same year amounted to about $193,000, only slightly more than one two-hundredth of the total revenue collected in 1917. In 1906, however, the total gross revenues amounted to less than three-tenths of 1 per cent of the total rural road and bridge expenditures for the year, and, furthermore, only a small portion of this revenue was really applied to road work. In 1917, however, the total gross motor-vehicle revenue of $37,501,237 amounted to about 12 per cent of the total rural road and bridge expenditures, and of this nearly 93 per cent was applied directly to the improvement or maintenance of the public roads in 47 states. Of the total amount applied to road work about 67 per cent, or $23,235,898, was expended more or less directly under the control or supervision of the state highway departments. The 7 per cent, or $2,812,633, not applied to road work was expended very largely for plates and in carrying out other administrative provisions of the motor-vehicle registration laws of the several states.

## Report Forms for Wisconsin Road Patrolmen

The 5,000-mile state trunk highway system of Wisconsin, provision for which was made by legislative act in 1917, is being maintained by the patrol system, supplemented in the majority of counties by small gangs for reconstruction and heavy repair work. Each county is divided into patrol sections of from 6 to 20 miles each. The sections are divided, where possible, so as to have only one type of road in a section. The county highway commissioner has direct charge of the patrolmen, and maintenance work in each county. Each patrolman is required to mail a daily report to the County Highway Commissioner and a second monthly report to the Division Maintenance Engineer. This latter official has general charge of the maintenance work in several centers. The forms used for these reports are shown in the accompanying illustration. The daily report shows the hours worked and the character and the location of the work. It also must show weather conditions for each day. The semi-monthly reports are made up from the daily reports.



WHC Form 92 (1918)

DAILY REPORT - PATROLMAN NO. 6

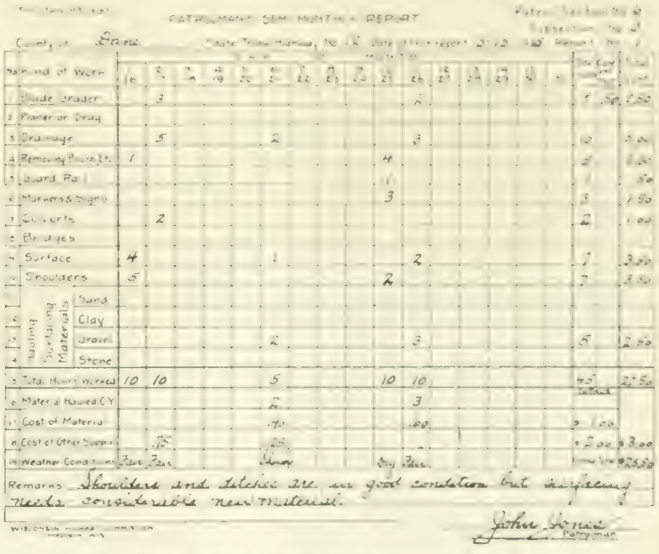
Day Monday Date 5-6 1918

| No. | Kind of Work | | Subsection No. 1 | 3 | | | Total |
|---|---|---|---|---|---|---|---|
| 1 | Blade Grader | | | | | | |
| 2 | Planer or Drag | | 3 | | | | |
| 3 | Drainage | | | 2 | | | |
| 4 | Removing Brush Etc. | | | | | | |
| 5 | Guard Rail | | | | | | |
| 6 | Markers & Signs | | | | | | |
| 7 | Culverts | | | | | | |
| 8 | Bridges | | | | | | |
| 9 | Surface | | | 1 | | | |
| 10 | Shoulders | | 2 | | | | |
| 11 | Hauling Surfacing Materials | Sand | | | | | |
| 12 | | Clay | | | | | |
| 13 | | Gravel | | 2 | | | |
| 14 | | Stone | | | | | |
| 15 | Total Hours Worked | | 5 | 5 | | | |
| 16 | Material Hauled C.Y. | | | 2 | | | |
| 17 | Cost of Material | | | .40 | | | |
| 18 | Cost of Other Supplies | | | 1.25 | | | |
| 19 | Weather Conditions | | Light showers | | | | |

Remarks: Blacksmith work 1.00; nails 0.25¢.

John Jones Patrolman

Daily Report of Patrolman.



PATROLMAN'S SEMI-MONTHLY REPORT

Semi-Monthly Report Compiled from Patrolman's Daily Report

**Trucks and Tractors for Road Dragging.**—Motor trucks and farm tractors are being used with success in dragging roads in many sections of Missouri. In Knox County a motor truck is being operated with night and day shifts for dragging all the inter-county roads. A small farm tractor has been used with excellent results in the inter-county seat road connecting Fulton and Jefferson City.

## The Asphalt Industry in 1917

The war has stimulated activity in the domestic markets for asphaltic material derived from crude petroleum and for imported asphalt, but the relative abundance and adaptability of those materials has lessened the demand for the native bitumens and for the various types of bituminous rock produced in this country, according to statistics just completed under the supervision of J. D. Northrop, of the United States Geological Survey, Department of the Interior.

The native bitumen, including maltha, gilsonite, elaterite and grahamite, bituminous rock, and ozokerite, marketed from mines and quarries in the United States in 1917 was 80,904 short tons, a loss of 17,573 tons, or 18 per cent, compared with 1916. The market value of the output in 1917 was $735,924, a loss of $187,357, or 20 per cent, compared with 1916. The production of gilsonite, bituminous sandstone, bituminous (elaterite) shale and ozokerite was increased considerably in 1917, but the gain credited to these varieties was insufficient to offset the loss in the production of elaterite, grahamite, and bituminous limestone.

The quantity of manufactured asphalt (including road oils and flux) produced in 1917 from petroleum of domestic origin increased about 2 per cent compared with 1916, and the quantity of corresponding material manufactured in this country from Mexican petroleum increased about 13 per cent, as a consequence of which the net gain over the production in 1916 was nearly 7 per cent.

The total sales in 1917 of manufactured asphalt derived from domestic petroleum amounted to 701,869 short tons, valued at $7,734,691. This total includes 327,142 tons, valued at $4,011,980, of solid and semi-solid products used in the paving and roofing industries, and 374,667 tons, valued at $3,722,711, of liquid products, including road oils, flux, and asphaltic paints.

The California output of oil asphalt from 14 petroleum refineries in 1917 aggregated 220,294 tons, valued at $2,100,252, and included 135,160 tons of solid and semi-solid products, valued at $1,486,609, and 85,134 tons of liquid products, valued at $613,643. Refiners handling oil from the Oklahoma-Kansas field produced 206,223 tons of oil asphalt, valued at $1,975,493, including 73,410 tons of solid and semi-solid products, valued at $747,651, and 132,813 tons of liquid products, valued at $1,227,842.

The total sales in 1917 of manufactured asphalt derived from Mexican petroleum amounted to 645,613 short tons, valued at $7,441,813, and included 338,485 tons of solid and semi-solid products, valued at $4,657,152, and 307,128 tons of liquid products, valued at $2,784,661.

The imports of native asphalt, oil asphalt, and bituminous rock for consumption in the United States in 1916 aggregated 187,886 short tons valued at $993,115, a gain in quantity of 40,173 tons, or 28 per cent, over 1916. The exports of unmanufactured asphalt in 1917 amounted to 30,107 short tons, valued at $587,256, a loss of 10,709 tons, or 35 per cent, compared with 1916. In addition asphalt products to the value of $585,472, compared with $494,895 in 1916, were exported in 1917.

## Iowa Counties Purchase Gravel Pits

Twenty-one counties in Iowa bought gravel pits for gravel road building during the season of 1917. The total cost of these pits, according to the Service Bulletin of the Iowa Highway Commission, was $20,442. Two counties, Kossuth and Clay, purchased five pits each. Calhoun bought four; Buena Vista, Cerro Gordo, Dallas, Dickinson and Linn bought three each. Buchanan County got two. Other counties buying one each were Greene, Hamilton, Hancock, Hardin, Black Hawk, Chickasaw, Pocahontas and Wright. Muscatine County reports the purhase of a pit for $1,800.

Iowa County Supervisors under a special law, are authorized to purchase gravel pits not to exceed five acres in extent. If purchase cannot be arranged with owners, supervisors are authorized to take possession by condemnation proceedings. Pits may be purchased so that no part of the county will be more than six miles distant from pits. The right is granted to township trustees to take gravel from these county owned pits. Road improvement companies, corporations and voluntary organizations are also granted the same privilege when the material is taken for public road improvement. The fine for using county material for private purposes is a minimum of $100 and a maximum of $500. Supervisors who fail to take advantage of the privilege of providing gravel pits are subject to removal from office proceedings.

## 18-Ft. Concrete Road Built by 2-Slab Method to Prevent Detours

In the construction of an 18-ft. concrete state highway in Connecticut it was impossible to provide satisfactory detours for the heavy traffic. As a result the road was built in two 9-ft. sections, separated by a longitudinal joint. No attempt was made to bond one side to the other. Traffic was allowed to use first the unimproved side and later the finished 9-ft. section. The method proved very successful as a means for taking care of the congested traffic, although it was a little more costly and took more time than the full slab method.

## Status of Federal Aid Road Projects

The Federal Aid road act was approved July 11, 1916, nearly 2 years ago. The status of the work under the law is summarized in Public Roads, the official publication of the U. S. Office of Public Roads and Rural Engineering.

Up to and including Feb. 28, 1918, there was a total of 383 project statements submitted, of which 265 have been approved, 6 disapproved, 3 canceled, and 4 withdrawn. Plans, specifications, and estimates have been approved to the number of 86. The total mileage covered by these projects was 4,453.66 and the total estimated cost $28,164,673, of which the state asked the Federal Government to assume the payment of $11,129,816.

In the number of projects Texas leads with 36, for improvements in 29 counties. Of these 11 have been approved. Texas also leads in aggregate amount of Federal aid requested. The first project statement from that state was submitted on Oct. 13, 1917, and the last on Jan. 22, 1918. They describe improvements upon 494.69 miles of road at an estimated cost of $1,864,565.03, and Federal aid to the extent of $857,453.71 is asked. In 1917 Texas expended between eight and nine millions of dollars in construction, improvement, and maintenance on about 13,000 miles of road.

In number of projects filed Alabama is second to Texas, with 29 covering improvements in 28 counties.

Illinois has submitted a single project, but it is the longest in point of mileage of any submitted, being for 75.6 miles of concrete and bituminous macadam resurfacing of the Lincoln Highway, at a cost of $1,146,673.50. The state requests 50 per cent in Federal aid. The next longest single project is one in Georgia of 73.85 miles of sand-clay or top soil to cost $180,630, of which the Government is asked to assume half.

Ohio has submitted 12 projects, aggregating some 68.62 miles, but the estimated cost is $2,201,757, and the Federal aid requested $651,080. This entire proposed construction is of either concrete or brick, with two exceptions, one being of 4.48 miles with optional macadam or concrete construction, and another of 5 miles with optional bituminous macadam or brick. Ohio leads the states in estimated cost of improvements to be undertaken.

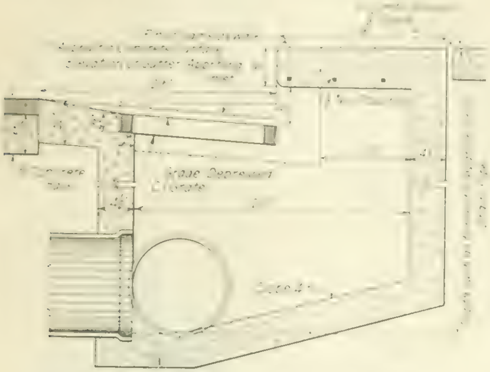
Kansas has come forward with three projects which cover 82 miles of construction upon which it proposes to expend $1,635,532 and requests only, $245,329 of Federal aid.

Michigan has filed 15 statements, of which 12 have been approved. Plans call for improvement of 141.25 miles at an estimated cost of $1,185,717, for which the state asks $603,978 of Federal aid. Gravel construction predominates largely, although the longest project—42.86 miles—is of graded earth.

Fourteen projects, of which 11 have been approved, have come from Iowa. They call for the improvement of 239.56 miles of road at an estimated cost of $1,034,525 toward which the Federal Government is asked to contribute $318,373. Proposed improvements are largely graded earth and gravel. Of the 14 project statements filed by Minnesota, 13 have been approved and 1 withdrawn. Improvements are contemplated on 268.42 miles of road, upon which it is planned to expend $781,673, with $358,742 of it in the form of Federal aid. Considerably more than three-fourths of the improvements are of gravel, the longest project of this type being for 50 miles.

## Special Type of Storm Sewer Inlet

A special type of storm sewer inlet built in connection with raised street intersections has given excellent satisfaction at Boulder, Colo. The inlet is a concrete box approximately 3 ft. deep, built partly under the sidewalk and partly beneath the gutter. A vertical opening 4 in. high and 2 ft. long through the face of the curb, with a cast-iron grating 2 ft. by 18 in. in size covering that part of the inlet box beneath the gutter, allows storm water to enter this inlet, from which it is carried by 12-in. pipes to a manhole near the center of the street. A smaller inlet constructed entirely of cast-iron, is also used. This inlet has a sloping bottom and is not designed to act as a catch basin, but the manhole into which the lateral pipes from the inlets discharge is carried down in the form of a circular well 3 ft. below the elevation of the storm-sewer leading from that manhole, thus forming a catch basin for coarse debris common to all four inlets at a typical intersection. The inlets are placed back of the property lines of the cross streets, and the pavement is brought up within 1 in. of the top of the curb around the intersection.



Storm Sewer Inlet Used at Boulder, Colo.

Mr. W. D. Salter, Director of Public Service of Boulder, advises that the plan of inlet was taken from a print furnished by A. G. Gregory, Engineer of Sewers and Water at Trenton, N. J. Certain modifications, however, were made. The principal change in the designs as built at Boulder, lies in the omission of the sump in the inlet. Instead a sump was provided in the manhole on the main sewer where the laterals from the inlets converge.

## Maintenance Cost of Concrete Roads in Milwaukee County

During 1917 the Highway Department of Milwaukee County, Wisconsin, had 109.34 miles or 1,148,167 sq. yd. of concrete pavement under maintenance. The maintenance cost for the road surfaced, according to the last annual report of the Department, was as follows:

| | | | |
|---|---|---|---|
| Labor | [illegible] | [illegible] | [illegible] |
| Material | [illegible] | [illegible] | [illegible] |
| Total | | [illegible] | [illegible] |

The cost of maintenance of the shoulders of these roads was as follows:

| | | |
|---|---|---|
| Labor | [illegible] | [illegible] |
| Material | [illegible] | [illegible] |
| Total | [illegible] | [illegible] |

## Resurfacing Wornout Pavements with Concrete

Resurfacing wornout road and street surfaces with concrete is becoming quite common practice. One of the earliest jobs of this kind was carried out by the city of Schenectady, N. Y. In 1909 a new cement top was built on a sheet asphalt surface, originally 3 in. thick, but which had worn down to 1 in. to $1\frac{1}{2}$ in. depth. The work is described by Mr. George A. Ricker in the Concrete Highway Magazine.

To replace the asphalt it was at first proposed to use granite blocks, but as this would have necessitated cutting out the old concrete foundation, and the blocks would not have presented as agreeable an appearance on the finest residence street in the city, it was decided to place a grooved concrete surface over the old concrete base. A 10-ft. strip was cut out of the center of the sheet asphalt and replaced with a rich concrete that was 3 in. in thickness, to within 18 in. of the edge, from which line it was sloped down to meet the surface of the asphalt.

The concrete mixture consisted of 1 part cement, $1\frac{1}{2}$ parts of coarse clean sand, and 3 parts of broken trap rock from $\frac{1}{4}$ to $\frac{1}{2}$ in. in size. A small amount of coloring matter was added, so that it would be nearly the same shade as the adjoining asphalt surface. Great care was taken in forming and finishing. No reinforcement was used. This 10-ft. strip of concrete is 480 ft. long, and has a grade of 6 per cent. Grooves were made in the surface, with great care and exactness, to represent blocks.

Notwithstanding the extreme thinness of this pavement, it has worn well. But a few breaks have occurred, and these have been patched with concrete so skillfully that their presence is unnoticed. The surface has worn some, but the grooves are still plainly shown. The City Engineer reports that the concrete has stood up well, although the sub-soil here, as at most points in Schenectady, is very bad—that the asphalt along the side of this concrete strip to the curb, has settled 2 in. within the last two years.

Here is an extract from the specification, under which this pavement was made that has really given such remarkable service in 8 years of hard wear:

> [illegible] paste, and thoroughly mixed. Broken stone, previously moist- [illegible] tinued until mortar covers the surface, but an excess of water [illegible] slight excess of water shall appear.

**Chicago Bituminous Specifications Allow Use of Slag Foundation.**—The Chicago specifications for bituminous macadam permit the use of slag for the foundation. The top, however, in nearly every instance is limestone to which a bituminous mixture is applied by the penetration method.

**American Society of Municipal Improvements to Hold Annual Meeting Oct. 2.**—The next meeting of the American Society of Municipal Improvements shall be held in Buffalo, N. Y., on Oct. 2, 3 and 4, 1918. The length of the convention is somewhat abbreviated and will be devoted strictly to business on account of the present conditions. George H. Norton, City Engineer of Buffalo, is chairman of the committee on convention arrangements.

# The "Genie" of France and How They Locate Enemy Guns by Sound Ranging*

No wonder the French called their engineers "Genie," thinking of the "Arabian Nights" and the genie that came out of the vase and accomplished all those wonders. They are the perfection of mathematicians. They have figured out the influence of the earth on a shell traveling out of the cannon; how much farther it will shoot north than south; how much the height of the moon deflects the shot, and what is called the ultimate error of the cannon shot is disappearing under their mathematics. If a commander cannot point a cannon within ten feet of the shot he is not counted a success. That is an engineering triumph and mathematical triumph of the highest degree.

Somebody asked me tonight how they located the guns and whether by aeroplanes. I said, "Not alone. There are three ways of doing it—spot flashing, sound ranging, and then the aeroplane to check both up." The most uncanny thing is sound ranging; it is shooting around the corner, surely. They have a very delicately devised wire that is heated red hot, and so sensitive that if you blow your breath on it it goes out. They put up six or eight of these wires at different points, all connected by electricity back to the central station, and then have a moving-picture machine. When an enemy gun goes off a button is pushed and the moving-picture machine goes into action, and as the vibration of that gun reaches each one of these stations there is a little quiver in the line that is printed on that film, and when it comes out it is handed over to the officer, and he goes to a carefully calculated table and proceeds to locate that gun by the vibrations taken miles away from where the recording instrument was, transmitted underground by wires buried six feet and brought back to this little encasement of his and printed; and those little strips of paper come back and locate the gun that fired that shot. Then he proves it by spot flashing, and as the sound travels from one place to another a number of people push a button, and, knowing that sound travels so many meters a minute, they prepare a map on which to locate it. Because paper expands and contracts, they make the map of zinc and they cut the paper in two-inch squares, so that nothing in accuracy shall be lost by the expansion or contraction of the paper under heat and dampness. They have a parabola around it with everything calculated, and stretch six strings around that, and when the six strings get over the same spot there is the gun, and when the other six strings get over there they are sure it is there, and then they get the airman to fly over it, and he can see if they are right, and it is nine out of ten if they drop a shot over there that that gun goes out of business. That is engineering gain. That is progress beyond the point where men set up a right-angled corner to set up a stone wall to put up a cheap house.

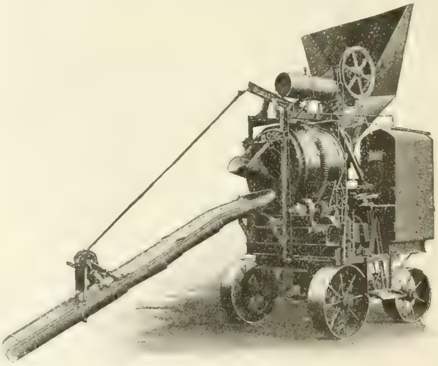
**Paving Blocks Cut from Old Granite Block Wall.**—The problem of disposing of a masonry wall around the old City Hall at San Francisco was solved by cutting the stone into paving blocks. The work was done by hand and the paving blocks were produced at a cost of $37.50 per 1,000. The men were paid $6 per day. About 75,000 6 in. deep by 7 to 8 in. long and 3 to 4½ in. wide paving blocks were obtained.

# How Maryland Patrolmen Count Traffic and Measure Road Wear

Patrolmen on the Maryland State Roads, in addition to their regular maintenance duties, make traffic counts and measure road wear. The traffic counts and measurements are made at permanent places on the patrol sections and are noted on printed sheets furnished by the State Road Commission. Bench marks are established on each side of the road at these places and pipes driven on each side of the road. In measuring the wear a light string with a weight at each end is placed over the pipes. The measurements are taken from this string to the road surface at 2-ft. intervals by a foot rule. Each observer carries a thermometer and notes the reading on his data sheet along with a short description of general atmospheric conditions.

# High Drum "Non Tip" Concrete Mixer

Improved types of Boss pavers have been brought out recently by the American Cement Machinery Co., Inc., Keokuk, Ia. These machines—known as Lincoln Highway Pavers, are built practically entirely of steel. One man handles them—all operating levers are banked within easy reach. They offer the contractor his choice of gasoline, kerosene, steam or electric power, and the gasoline and kerosene machines are stated to have demonstrated the fact that they are as reliable as steam. Lincoln Highway Pavers are all built with high drums—bottom of discharge spoon 6 ft. from the ground. Danger of tipping is eliminated by specially wide track and wide tires. The chute is sectional, with three gates, and allows dumping of concrete right up to the paver.



Lincoln Highway Paver.

**Opening Up Snow Roads with Plow and Roller.**—In some of the Canadian counties where plows and rollers have to be used after every heavy snow storm, it has been found that the best results are obtained by using the roller immediately after the snowplow. In this case the snowplow would be required to remove only a small amount of snow. The action of the roller is to press down the sides of the road evenly, thus providing a width of 12 or 14 ft. of hardened snow, which is very desirable.

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*From an address by Maj. Gen. Charles M. Clement, U. S. A., before the Philadelphia Association of Members of the American Society of Mechanical Engineers.

# $20,000,000 Expenditure Proposed for Construction and Maintenance of Highways for Motor Truck Parcel Post Service

A comprehensive plan for the extension of the motor truck service on star routes by the Postal Department and for the construction and maintenance of the highways over which it is operated was outlined by Fourth Assistant Postmaster General Blakslee in a statement submitted June 21 to the Committee of Post Office and Post Roads of the House of Representatives. The statement was submitted at a hearing on the resolution to authorize the Postmaster General to expend 50 per cent of the gross earnings of motor truck parcel post routes for the construction and maintenance of highways. The statement follows:

The operation of the limited number of motor truck star routes established through producing territory between important market centers discloses such remarkable returns in improved service to the patrons thereof and increased revenue to the postal establishment as to warrant immediate legislative action upon the further extension of the service and the construction and maintenance of highways over which it is operated.

In previous hearings before this committee it was contended that direct means of conveyance from producer to consumer would increase production and permit the producer to confine attention to maximum production, thereby offset the loss of man power diverted from the farm to engage directly and indirectly in the prosecution of the war.

This contention has not only been confirmed through the actual operation of the routes but a vastly improved collection and delivery of ordinary mail is noted. Numerous handlings have been eliminated and direct facilities from post office to post office provided, thereby advancing delivery of mail to patrons many hours.

The efficient and economical operation of this service is dependent upon three primary factors: The highway, the vehicle and the commercial convenience of the patron. Utilizing an extremely small portion of the 160,000 miles of improved, hard-surfaced highway in the country, the Department established the motor truck star routes and the following tables indicate earnings as accurate as could be obtained without delaying the mails and also the complete and exact cost of operation of each and all routes including every conceivable overhead or indirect charge:

POSTAL RECEIPTS AND [illegible]

[illegible]

| Route Number and Termini | Receipts [illegible] | [illegible] | [illegible] |
|---|---|---|---|
| [illegible] | $ 2,705.25 | $ 3,605.77* | [illegible] |
| 1328 [illegible] Md. | 33,604.82 | 3,554.74 | [illegible] |
| [illegible] Washington, [illegible] Leonardtown, Md. | 40,655.04 | 4,700.83 | 35,754.21 |
| [illegible] D. C.; Baltimore, Md. | 23,135.34 | [illegible] | 19,218.50 |
| [illegible] Md.; Lancaster, Pa. | 19,072.22 | 3,056.28 | [illegible] |
| [illegible] | 28,717.67 | 6,367.37 | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] Zanesville, O. | [illegible] | 977.34 | [illegible] |
| Total [illegible] | [illegible] | [illegible] | [illegible] |

*Loss. †Net profit.

It will be noted that there is very substantial surplus earnings and it naturally follows that the use of the highways by Government owned equipment for such profitable enterprise without compensation to the states or subdivisions thereof, except improved mail facilities to the residents domiciled therein, is neither equitable or just and consequently the Federal Government may be under a moral obligation to reimburse the states in some substantial manner, and it is believed that this can be done with benefit to the states and at the same time further increase the profitable possibilities to the Federal Government.

The joint resolution under consideration authorizes the use of not more than 50 per cent of the gross earnings of motor truck parcel post routes be expended for the construction and maintenance of the highways on which the service is or may be established.

A survey of possible through or connecting routes east of the Mississippi River indicates approximately 7,500 miles of through or connecting highway to be covered, of which at least 5,000 miles would be essential to successful motor truck service. It is assumed that a similar mileage would be necessary west of the Mississippi River, although no definite survey has as yet been completed.

Five thousand miles of permanent roads, exclusive of bridges and municipal streets, already completed and not included in contemplated construction, would cost about $20,000 per mile, using every possible economical method of construction, including convict labor where available, prisoners of war, and local road making materials, thus the entire 7,500 miles would cost about $150,000,000. This estimate will be confirmed by qualified engineers; 5,000 miles would cost approximately $100,000,000.

One thousand, of a possible 5,000 cars, operating east of the Mississippi River on this road or adjacent thereto, should earn, based upon statistics here presented and which were obtained in territory where keen competition from available means of conveyance appear $40,000 each per annum, or a total of $40,000,000 yearly, from which sum should be deducted annually $5,000,000 for cost of operation of cars, $10,000,000 for indirect cost of transportation of mails to and from the routes, and $5,000,000 for extensions and additional service, and the remainder, or $20,000,000 per annum, could be applied for the construction and maintenance of a national highway.

It may be asserted that the earnings include a portion of existing postal revenue and would tend to reduce present postal income now derived, using other means of transportation.

Ten thousand routes earning $40,000 each per year would produce $400,000,000 per annum or more than the total annual postal revenues at this time. There are 60,000 rural and star routes in operation in the postal service, therefore 10,000 motor truck routes would not be an unusual or a startling number, and if each route transported but 100 lb. of first class mail daily the revenues would be $45,000 per year. Thus of the total of 10,000 possible routes at least 1,000 can be located where the income will certainly not interfere with existing postal revenue and as above stated the surplus earnings of those 1,000 routes will in due time build and maintain the proposed Federal road regardless of what mailable matter will be diverted to the motor truck service established thereafter on the proposed road, and which is now transported by other mail facilities. Such diversions would occur only because of the more direct collection and delivery provided or by reason of short distance via truck route as ever against long detours through transfer points by mail or water.

There is no rail or water transportation possible between Baltimore and Solomon's Island nor between Washington and Leonardtown and there are over 1,000 similar localities east of the Mississippi River. A simple calculation of the net earning on either of these two routes multiplied by 1,000 will probably answer the assertion.

The Post Office Department may be relied upon to secure a dollar's worth of return for every dollar of the people's money expended through the Department, and it is entirely competent to honestly and economically use every cent of revenue for the construction, maintenance and use of highways, it is nevertheless cognizant of and agrees with the very substantial sentiment that prevails in Congress and elsewhere that an indefinite or unlimited authority to utilize earnings for any direct or indirect means of increasing revenues or in other words to take advantage of a revolving fund, is a dangerous fiscal policy and leads to adverse criticism and fault finding, and therefore the adoption of the resolution under consideration in its present form would be embarrassing and it is suggested that it be modified to provide for a definite amount to be set aside out of moneys in the treasury not otherwise appropriated, this sum or any part thereof to be used only after the Postmaster General certifies to the Secretary of the Treasury the amount of the gross earnings of the motor truck routes for a stated period.

This method will properly protect the interests of the tax payer and will materially promote the improvement of the highways without at any time placing the Post Office Department under suspicion of spending more than the Congress intended or using postal revenues in other than a strictly legitimate manner.

The construction of the proposed through or connecting route highway as illustrated is in nowise to displace or otherwise interfere with the existing system of construction whereby the states in conjunction with the Federal Government are building many miles of excellent road and the completion of the feeder lines to the National Highway under the Federal Aid plan already effective is undoubtedly essential to National prosperity and welfare. But this line is as valuable in its availability as an item in the system of National defense as it is an avenue of commerce and therefore of direct National importance and will unquestionably demonstrate its value more and more as the increasing necessities for the use of highways as a means of transportation appear.

The apparent excessive cost per mile is accounted for by reason of the type of construction contemplated which included a concrete or brick paved road not less than 16 feet wide, not less than 9 in. top depth with heavy grouted under foundation thoroughly underdrained for the entire distance, thereby making for a permanent road with extremely limited after-maintenance. No other type of road construction will withstand the exigencies of modern uses without abnormal after expense for upkeep.

Differing climatic, topographic, labor and material conditions will materially affect the celerity of construction and cost thereof and every advantage should be taken to provide for work and materials, necessary at points where these factors in road building will not seriously conflict with the first duty of the Nation to win the war. However, a judicious program partially prepared now, partly produced now and later entirely developed will be extremely valuable as a National policy for the employment of thousands of returning victorious veterans who will thoroughly appreciate the value of permanent highways as exemplified in France and without which our cause abroad would today confront disaster.

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**Work of American Road Building Battalions in War Zone.**—It is estimated that American road engineers will construct 1,200 miles of highways during 1918 in the rear of the firing line in France. To the special road building battalions is delegated the important task of keeping lines of communication constantly open, and trucks working in conjunction with modern American road machinery will help to build new strategic lines and keep communicating roads in constant repair. The fleet will be composed of several thousand dump trucks, hot road oilers, pressure sprinklers for making waterbound macadam, gasoline tank trucks, printing press trucks for printing blue prints, instructions, plans, reports, etc., machine shop trucks, blacksmith and tool repairing trucks. Most of the roads of France are built of waterbound macadam. The British, however, introduced the tarred surface road and an increasing mileage of that type is found back of the British lines. One of the principal objections to the waterbound macadam road near the front is the dust which rises from it in dry weather under heavy war traffic. Clouds of dust draw artillery fire from the enemy, and for this reason United States engineers, in planning road construction and maintenance near the American front, will probably utilize large quantities of tar coating, which is freely obtainable in France.

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**Convict Labor Enables Milwaukee County Highway Department to Complete Its Construction Program.**—Practically all the work planned for the season of 1917 by the Milwaukee (Wis.) County Highway Department was finished, despite the scarcity of material due to the national car shortage, and the unprecedented labor situation. This result, states the last annual report of the department, may be attributed, in a large degree, to the installation of convict labor. At the beginning of the season the labor aspect, by virtue of the world war, was anything but promising. Contractors, due to the independence of common labor, found it absolutely impossible to organize labor into efficient crews. This handicap was removed entirely by the use of House of Correction labor. Over 500 ft. of 18-ft. concrete pavement has been poured in a day's time with this type of labor.

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## Personals

A. V. Gibson, of Kalispell, Mont., has been appointed a member of the State Highway Commission of Montana.

Jack Cotton and H. C. Snoddy have been appointed field engineers for the engineering department of Harris County, Texas.

John K. Harris and H. W. Cole have entered into a partnership under the firm name of Harris & Cole, with headquarters at Farrell, Pa.

Gregg Black has been appointed city engineer of Vicksburg, Miss., succeeding C. R. Twiss, recently commissioned captain in the Engineer Corps, U. S. Army.

Burwell Bantz, formerly county engineer, Island County, Washington, has been appointed city engineer and superintendent of water works for Chehalis, Wash.

C. E. Henderson has resigned as county engineer of St. Johns County, Florida, and has entered the service of the U. S. Bureau of Industrial Housing and Transportation.

H. G. Merriweather, for 30 years connected with the engineering department of Denver, Colo., has resigned as assistant city engineer and will engage in private practice.

Harry A. Rager, chief bridge engineer for the State Road Commission of Utah, who has been in the state's employ for about a year, has resigned to enlist in the 473d Engineers.

George W. Tillson, formerly chief engineer of the Bureau of Highways, Manhattan and Brooklyn Boroughs, New York, has resigned as consulting engineer to the president of the Borough of Brooklyn.

F. W. Pattison, of New Westminster, B. C., has been appointed municipal engineer for Langley, B. C., to succeed E. H. Verner, who has been appointed assistant district engineer for the Delta and Chilliwack, riding under the public works department.

*Waterworks and Hydraulics*
*Monthly Issue*

ENGINEERING AND CONTRACTING

HALBERT P. GILLETTE, *President and Editor.* LEWIS S. LOUER, *Vice President and General Manager*

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**Roads and Streets—1st Wednesday**
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies

**Waterworks and Hydraulics—2nd Wednesday**
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power

**Railways and Govt. Works—3rd Wednesday**
(a) Excavation and Dredging (c) Harbors and Docks
(b) Rivers and Canals (d) Railway Construction

**Buildings and Structures—4th Wednesday**
(a) Buildings (c) [illegible]
(b) Bridges (d) Miscellaneous Structures

Volume L. CHICAGO, ILL., JULY 10, 1918. Number 2.

# All Manufacturers Supplying Public Utilities and Railways Are to Get Iron and Steel

On June 6 the war industries board and the producers of iron and steel entered into an agreement under which no iron or steel is to be sold to consumers except by certificate issued by the priorities division of the War Industries Board. It was agreed that preference treatment will be given to the following industries:

(Including all necessary raw materials, partially manufactured parts and supplies for completion of products.)

**Ships.**—Destroyers and submarine chasers.

**Aircraft.**

**Munitions, Military and Naval Supplies and Operations.**—Building construction for Government needs. Equipment for same.

**Fuel.**—Domestic consumption, manufacturing necessities named herein.

**Food and Collateral Industries.**—Foodstuffs for human consumption and plants handling same; feeding stuffs for domestic fowls and animals and plants handling same. All tools, utensils, implements, machinery and equipment required for production, harvesting and distribution, milling, preparing, canning and refining foods and feeds such as seeds of foods and feeds, binder twine, etc. Products of collateral industries, such as fertilizer, fertilizer ingredients, insecticides and fungicides. Containers for foods and feeds, collateral products. Materials and equipment for preservation of foods and feeds, such as ammonia and other refrigeration supplies, including ice.

**Clothing**—For civilian population.

**Railroad**—Or other necessary transportation equipment, including water transportation.

**Public Utilities**—Serving war industries, army, navy and civilian population.

Among these eight general heads it is important to note that "public utilities" are included as being entitled to preference above other consumers of iron and steel. The term "public utilities" has come to mean all "plants" that are either owned by the public or that serve the public through the agency of companies operating under franchises or charters. Although railways are public utilities, they are commonly mentioned separately because they render interstate or national service.

Water works, sewers, railways, roads and streets are among the public utilities that most particularly concern the readers of Engineering and Contracting. It is therefore gratifying to note that all doubt is at an end as to the supply of iron and steel for these public industries during the war. Some manufacturers of machinery, materials and supplies for the civil engineering and contracting field had been in doubt as to their ability to secure iron and steel, in view of the Government's requirements for war purposes. It is now clear that these manufacturers will not be seriously curtailed, at least after the new priority system has become well organized. Since the war industries board is keenly aware of the necessity of eliminating delay in issuing priority orders, we may look for the rapid evolution of a system that will reduce red tape to a minimum.

# Three Engineers Who Engineered a New Government for a City

For a dozen years this journal has been urging engineers to become managers of public and private plants and to take an active part in public affairs. Engineering societies are at last beginning to realize that it is the duty of engineers to become public leaders. Most engineers apparently are ready to take part in any public campaign that their society may begin, but few seem to realize that they can themselves begin without waiting for organized support. Among the few are Clair V. Mann, Prof. H. S. Evans and Asst. Prof. H. F. Phelps of the University of Colorado, who began to agitate nearly two years ago for a commission-manager plan of government for Boulder, Colo. They were successful in carrying the plan into effect, and they now form three of the nine members of the commission.

The commission has appointed a city manager and certain advisory boards and city officials. Under the city manager there are six departments. Two of these, public service and public health, are headed by engineers. The charter provides that the director of public service must be an experienced municipal engineer, and he is ex-officio city engineer.

What these three engineers brought about in Boulder, a city of 12,000 people, other engineers can bring about in other cities. Do not wait for others to lead or for some engineering society to support your efforts. Take the initiative yourself in your city. The time is ripe and the war is causing people to welcome plans to improve city government. Write to H. S. Gilbertson, secretary of the National Short Ballot Association, 383 Fourth Ave., New York City, and ask for data and guidance.

## Drainage, Irrigation and the Use of Better Farming Methods Would Double the Crops of the Mississippi Valley

Luther Burbank has just announced the production of a new species of wheat that will yield 50 bushels to the acre where 12 is now the average. When we speak of the practicability of doubling the crops in the Mississippi Valley we do not refer to the use of new varieties of plants, such as the wizard Burbank has "invented," but to the use of well-known agricultural methods and the application of civil engineering.

Lack of knowledge, lack of capital and lack of engineering constitute the triumvirate of obstacles to greatly increased agricultural output. In spite of all that the Department of Agriculture, the agricultural colleges and the farm papers have done, the average farmer remains largely ignorant of the most economic procedure. This very ignorance stands in the way of his seeking the capital that he could profitably employ, and it deters him also from seeking engineering assistance.

It would seem that here, if anywhere, a paternalistic government would be efficient. Such a Government would not merely tell farmers what should be done, but it would insist upon their doing it.

Drainage and irrigation would alone nearly double the productivity of Mississippi Valley lands, as has been established again and again on a large scale. Practically all this land is greatly benefited by tile drainage, to say nothing of the drainage of swamp lands. Irrigation by pumping is practicable for most of this land, and it not only insures against crop failure but adds greatly to the annual crop yield.

There are about 80,000,000 acres of swamp and overflow land in America that can be reclaimed; but at the rate of reclamation that has existed in recent years, another half century will have elapsed before it will have been reclaimed.

The Department of Agriculture estimates that about 150,000,000 acres, or nearly one-third of all improved farm land, is so badly in need of tile drainage that it is producing only one-fifth as much as it would produce if drained. Yet less than a million acres of the 150,000,000 are annually improved by tile drainage!

Drainage and irrigation are civil engineering works, and it seems to us to be the duty of civil engineering societies to take steps that will lead to Government action designed to hasten the rescue of 200,000,000 acres of tillable land—nearly all in the Mississippi Valley—from its present condition of inefficiency.

## The Lesson Taught by the Failure of the Calaveras Dam

Four months ago, and four years after work was begun, the highest earth dam in the world failed before construction had been completed. We refer to the Calaveras dam, about 36 miles southeast of San Francisco.

The dam lacked only 40 ft. of having reached its full height of 240 ft. above bedrock or 210 ft. above ground level, when about one-third of its entire mass slid out, fortunately causing no loss of life. Some 800,000 cu. yd. of the upstream face slid or flowed out. The downstream side remained intact. Most of the downstream part and much of the upstream part had been placed from dump cars, but the central part had been delivered through a pipe and was still wet when the slip occurred.

The failure did not occur without warning, but the great mass of earth slid out within five minutes after it started to go. There had been a slight horizontal movement of the upstream slope of the dam as early as June 18, 1917, whereupon sluicing was discontinued until Feb. 12, 1918, except for a period of 12 days in the summer of 1917. Evidently the engineers believed that eight months' "rest" had been sufficient to dry out the clay fill; but it is equally clear that they were badly mistaken, for on March 4, or three weeks after sluicing had been resumed, another slight horizontal movement of the upsteam face occurred. Sluicing was again stopped, but 10 days later, March 14, the failure occurred.

The depth of the hydraulic fill in the center was 155 ft. at the time of failure. In five minutes 800,000 cu. yd. slid out, leaving about 2,000,000 cu. yd. still in place. The 2,000,000 includes the whole of the downstream part of the dam. At the time of the failure the reservoir was partly full, the water being about 55 ft. deep. The cost of replacing the upstream material will be more than $500,000. The original estimate of the cost of the complete dam was $2,500,000, and it was to have contained 3,085,000 cu. yd.

Civil engineers will be interested primarily in knowing what precautions were taken to prevent the failure and what precautions should be taken in future works of similar character.

Beginning March 16, 1916, it was the practice to have a man periodically force a 1½-in. pipe into the hydraulic fill, and this practice was continued till Jan. 24, 1917, when the "ball test" was adopted. The material in the core was so plastic that the pipe could be forced down to a depth of 90 ft. On Feb. 12, 1917, the ball test was begun, and it was found that a 6-in. cast iron ball sank by its own weight 45 ft. into the soft clay fill, or half the depth that the pipe was forced. By July 27, 1917, the depth of penetration of the ball was 35 ft.; a month later it was 12 ft.; and on Jan. 21, 1918, it was only 5 ft. From this it was apparently reasoned that the fill had dried out sufficiently to be safe.

Hindsight now makes it clear, we think, that this "ball test" was very deceptive, in spite of its seeming greater accuracy than the pipe test. It is now evident that not only should the pipe test have been continued, but that other tests should have been made. Samples of the interior of the dam should have been secured and a determination made of the percentage of water present. It has been suggested by A. W. Goldbeck, Engineer of Tests of the Office of Public Roads, that soil pressure "cells" should be buried in a fill of this character, and pressure readings taken at intervals, at a cost not exceeding $500 for a large dam.

The editor of Engineering and Contracting designed a crude soil pressure cell that was described in this journal some ten years ago. Mr. Goldbeck has devised a very accurate soil pressure cell, which was illustrated and described in our issue of June 27, 1917, and he has recently used it for determining the pressure of clay in a tank.

The failure of the Calaveras dam finds a counterpart in the failure of the Necaxa dam No. 2 in Mexico on May 20, 1909. The Necaxa dam was also a hydraulic fill, and 720,000 cu. yd. of wet clay slid out on the upstream side when the fill had reached a height of 172 ft. The upstream slope was 3 to 1, and there was no water in the reservoir at the time of failure. Just prior to the failure a pipe was forced into the clay to a great depth.

The Calaveras dam was being built by day labor for the Spring Valley Water Co. to impound 53,000,000,000 gal. Its top length was to be 1,300 ft. and its top width 25 ft. The upstream slope was 3 to 1; the downstream slope, 3½ to 1; and the maximum distance between upstream and downstream toes, 1,312 ft. Its finished height at the center was to be 210 ft. above ground level, plus 30 ft. above the bottom of a wide excavation to solid bed rock. About half the material in the dam was a dry rock fill used in both toes; the rest was an earth fill deposited by hydraulic sluicing. This earth fill was half clay and half sand and gravel hydraulicked from nearby hills. The coarse material was crushed before entering the conveyance pipes. The hydraulicked material was dumped on the edge of the pool, thus permitting the clay to separate and flow to the center of the pool.

Upon failure a section of the upstream part, about 700 ft. long, slid out, swinging out like a huge door. The water in the reservoir, which stood 55 ft. deep, was not released, and the slide did not extend much below the level of the water. The lower part of the slope had been paved with concrete which extended 13 ft. above the water level. Above that the paving was heavy riprap.

It is planned to finish the dam. Upon its completion it will be the highest earth dam in the world.

George A. Elliott is engineer of the Spring Valley Water Co. and William Mulholland, of Los Angeles, is consulting engineer.

## Civil Engineers Should Operate Sewage Treatment and Other Municipal Plants

It has been suggested that every sewage treatment plant should be operated by its designer for at least one year after its completion, instead of following the common practice of turning it over to a street foreman or some ignorant city official. A state board of health might make it compulsory for the designing engineer to operate the plant for a year, it is said. Good. But why stop at that? If it will benefit the city and also make the engineer a better designer if he is required to operate the plant for a year, even greater benefit will result from lengthening the time.

Yes, and the final answer is not to be had by making the engineering operation of the plant come to an end after a stated period. Every sewage disposal plant should be operated by some engineer forever. It should never be turned over to an untrained man.

Civil engineers throughout America should co-operate in a movement to convince the members of every chamber of commerce that it requires a managerial engineer to run a sewage disposal plant economically and efficiently. Indeed this principle applies to street cleaning and street repairing plants, and to water works also. The men who design these plants should have an administrative voice in their operation; but they will rarely secure such control unless they bestir themselves to get it.

## Why Civil Engineers Should Formulate Policies of Municipal Improvement During the War

State and municipal bond issues have decreased greatly since our entrance into the war. The bond issues for the first four months of each of the last six years have been as follows:

[illegible]

Without doubt the Liberty Loan drives have made it somewhat difficult to market municipal bonds, but the main reason for the falling off in such bond issues is to be found in the false ideas of economy that were created by governmental appeals to sacrifice everything to win the war. Mr. McAdoo is largely responsible for having brought about this undue slackening in municipal construction, because his first appeals to the public to buy Government bonds were so worded as to lead to the belief that almost every kind of construction, save Government works, should cease. He has recently issued a statement that all necessary building should not cease, and, as director general of railways, is about to spend half a billion dollars for railway construction, in addition to an equal amount for rolling stock.

Considerable mischief has already been done through public misapprehension of the extent to which "economy" should be practiced by cities and states. But there is evidence of returning sanity. In another editorial we comment upon the inclusion of "public utilities" among the eight "war industries" that are to receive preferential treatment in securing iron and steel. If, now, civil engineering societies will bestir themselves, city officials can be made to realize that true economy demands no let up in city improvements during the war, for the war industries board itself recognizes that public utilities are entitled to preference. Public health calls for the carrying out of all sewer projects and nearly all water works projects. Economy of haulage calls for street improvement on as large a scale during the war as ever; for streets are not only "the other end of railways" but a public utility upon which the economy of all haulage and delivery of goods in cities depends.

Now, if ever, let civil engineers take leadership in formulating and carrying out municipal policies. That such leadership is badly needed may be inferred from the panicky curtailment of city improvements during the first half of 1918.

# An Opportunity for the Construction Industry to Assist the Government

To the Editor: We are enclosing a copy of letter dated June 27, received from Mr. Harry A. Wheeler, President of the U. S. Chamber of Commerce at Washington, inviting the American Society of Engineering Contractors to participate in a national convention of the building construction industries, to be held at Atlantic City, July 15 and 16.

We should be very glad to have you print this invitation as well as this letter, as the American Society of Engineering Contractors is the only national organization of construction engineers and contractors on engineering construction, and we should like engineers and contractors, whether affiliated with this national society, local societies, or unaffiliated, to feel that we are broad enough to welcome at this convention any member of the profession.

We cannot urge upon you or your readers too strongly the necessity for national grouping of the construction industry, as it is the only industry unorganized as such, for co-operation with Government agencies, in our supreme effort to win the war, and to co-operate now or in the future reconstruction, in a patriotic, efficient and equitable manner.

Our society last March initiated a national conference with a sincere endeavor to realize our responsibilities and opportunities. We had been urged by the Council of National Defense at Washington to gather all the forces of our industry and profession into a united group for effective aid for national purposes, and at their request have joined the Chamber of Commerce of the United States in order to co-operate through a War Service Committee with similar organizations of allied industries.

Through the assistance of the National Association of Builders' Exchanges and the National Builders' Supply Association, we have succeeded in interesting the Chamber of Commerce of the United States in organizing a National War Service Committee of the industry.

We feel that we would be remiss in our duty, as president of the American Society of Engineering Contractors, if we failed to urge upon the contractors of the country the seriousness and vital necessity for national co-operation, and we believe that vital results can grow out of the coming convention. We appreciate that the large contracting organizations throughout the country are apt to feel that they are able to take care of themselves, and are inclined to neither give assistance or ask assistance. Such action on the part of any contractors working on a Government contract or a private contract, with or without prospects for additional work, should nevertheless make them realize that this will be their only opportunity to signify their willingness to assist the Government in its present and future aims.

In conclusion, therefore, we beg to invite the attendance at the convention of such contractors as can possibly send representatives to this convention, and to such as cannot, if they will send us their names to 504 Century Bldg., St. Louis, Mo., we shall be glad to keep them informed as to the results of the convention, and future efforts of the profession.

Let us all join in this patriotic purpose.

A. P. Greensfelder, President,
American Society of Engineering Contractors.
St. Louis, Mo.

**Invitation from U. S. Chamber of Commerce.**

You are invited to attend a convention of representatives of the Building Industries to be held at Atlantic City on Monday and Tuesday, July 15 and 16.

Business: To consider ways and means whereby the various divisions of the building industries can find a common ground upon which they may give coordinate assistance to the Government during the war; to develop machinery whereby the industries can speak with a united voice upon matters affecting all interests involved, and consider plans for the reestablishment and maintenance of the general prosperity of the industry as a whole.

It is desired to have the convention as thoroughly representative as possible. Your organization is asked to send as many delegates as may be induced to attend the convention, but it is requested that your organization shall name one delegate—preferably a prominent business man—who shall be authorized to speak for your organization and who may be recognized as willing to serve upon a Central War Service Committee.

For your information, it may be pointed out that this is one of a large number of trade groups convening at the suggestion of the War Industries Board. If national organization is effected, the Central War Industries Board and its several departments through the certification of the Chamber of Commerce of the United States.

The convention takes place at the Hotel Marlborough-Elenheim and commences at 10 o'clock on Monday, July 15.

Harry A. Wheeler, President,
Chamber of Commerce of the United States.

# Labor Saving Machinery in Water Works Service

The value of labor saving machinery to the water works superintendent was pointed out by Mr. J. A. Jensen, Superintendent of Water Works of Minneapolis, Minn., in a paper presented last fall before the Minnesota section of the American Water Works Association. Excerpts from his paper follow: On work in limestone ledge, trenching for pipe laying, an air compressor and operator with two plug drills and two men replaced 20 men with hand drills. In laying steel pipe the same compressor with 10 boiler makers equipped with the necessary riveting and calking hammers, reaming tools and other equipment carried on the work of a whole company of similar skilled labor with hand tools.

A single first-class power operated trench pump has been found to do as much work as three hand-operated pumps manned by a dozen laborers.

In 1913 the city of Minneapolis purchased a large trenching machine for use on several miles of trunk pipe lines. This machine put out 39,200 cu. yd. of earth at a unit cost of 9.3 ct. per cubic yard on about 3 miles of trench. On another piece of work a steam shovel on back-fill handled 23,730 cu. yd. on 9,250 ft. of trench at a unit cost of 4.8 ct. per cubic yard.

In service work at Minneapolis with miscellaneous jobs scattered over 40 or more square miles of territory, Ford runabout trucks are employed, each rig and two men, generally speaking, replacing three single-horse rigs and six men. This is explained by the fact that the principal part of the performance in street service is mileage, and the work itself is secondary so far as time element is concerned.

# Methods and Costs of Pumping for Irrigation in Arkansas River Valley

Numerous irrigation pumping plants are now being operated by farmers in the Arkansas River valley of Kansas. A summary of the practice in this district has been issued recently by the Division of College Extension of the Kansas State Agricultural College. The bulletin is the result of observations of the various pumping experiments made in the most part by H. B. Walker, formerly state drainage and irrigation engineer. It has been prepared by Mr. J. B. Marcellus, drainage and irrigation engineer, from the notes and material collected by Mr. Walker. The matter following has been taken from the above-mentioned bulletin:

**Location and Kind of Well.**—The general practice in the upper Arkansas river valley is to put in a battery of wells and connect all of these to a common suction pipe attached to the pump. These wells are usually placed at right angles to the underflow and about 30 to 40 ft. between centers. In some cases as many as 12 wells are attached to one pump, while in other cases, where the gravel and sand are coarser, it is only necessary to put in three or four wells. The battery of wells is practical for the Arkansas river valley, as the distance to water usually does not exceed 25 to 30 ft.

In the lower Arkansas river valley the water-bearing sand seems to be a little coarser, and it is quite possible to sink a single well and secure a quantity of water ranging from 300 gal. to 1,000 gal. per minute. In such cases a well pit, usually 6 ft. in diameter, is excavated down to the water-bearing stratum. In the bottom of the well pit a steel casing, properly perforated, and ranging from 24 to 36 in. in diameter, is sunk through the sand and gravel. Where a battery of wells is constructed the casing is usually 15 in. in diameter, and is properly perforated to permit the water to enter and to exclude the gravel and coarser sand.

In any case the well is a very important part of an irrigation plant. It should not be located until proper tests are made, and great care should be used in its construction.

**Well Casings and Strainers.**—It is the general custom throughout the valley to use ordinary galvanized iron, usually 16 gauge, for the casings and strainers. These strainers will last for a long period of years if they are not too large in diameter, and unless the water is more or less salty. It is not unusual, however, for the casings to fail, due to the use of too light a material for wells 24 or 36 in. in diameter. Cement casings are used to some extent. All cement casings should be properly reinforced to withstand the pressure of the sand and gravel from the outside. The function of the strainer is to exclude the sand and gravel and allow the water to enter the well. The strainer should have 20 to 30 per cent perforations and should not be placed in very fine water-bearing material. A well may be developed by pumping the fine sand out and packing the outside strainer with broken stone or coarse gravel.

**Kind of Pumps.**—Actual experience in the pumping field demonstrates that the centrifugal pump is best adapted for pumping large quantities of water. These pumps have a few moving parts, are simple in construction, are capable of handling a large quantity of water, and also can successfully pump a considerable quantity of sand without injury to the pump.

The farmer should select a simple type of centrifugal pump. For pumping heads of [illegible] ft. or less, the ordinary single-stage centrifugal pump is best adapted. This pump may be either the horizontal or vertical type. Where the distance to water is 20 ft. or less, it is the practice to use a horizontal, single-stage, side-suction centrifugal pump. This pump is placed in the well pit as near the water line as possible, and a belt run is excavated so that the line of the belt will be on an angle of about 45° with the horizontal. The engine is placed on the surface of the ground. Such pumps are simple in construction, are very easy to keep in alignment, and when properly cared for will last a number of years.

Where the distance to water exceeds 20 ft. it is the practice to install a vertical centrifugal pump. This pump is similar in construction to the horizontal one, except that the impeller is operated by a vertical shaft. This makes it possible to place the bowl of the pump beneath the water surface; the vertical shaft is run to the ground surface, and the pump is operated by a quarter-turned belt attached to the driving power. Such pumps should be carefully installed in order that the shaft will be perfectly aligned. It is preferable to hang the pump from the surface of the ground, rather than to attach it to the well casing. A single-stage pump gives excellent satisfaction.

In order to secure the highest efficiency from centrifugal pumps there must be a definite relation between the speed of the pumps and the lift of the water. Any change in this speed directly affects the efficiency of the pump. It is important, then, that the pump owner should know the proper speed at which to operate the pump in order to secure the greatest efficiency for the conditions of the lift. Reliable manufacturers furnish data with their pumps which enable the purchaser to determine the speed at which the pump should be operated to insure the best results for different lifts. If purchasers will require such information with their equipment and will install machinery which is suited to their actual working conditions, there will be less complaint concerning the lack of efficiency of modern centrifugal pumps, and more profit will be realized from the pumped water.

**Amount of Water Required.**—The area of land which can be irrigated from a well will depend upon the flow of water and the character of the land to be irrigated. If a farmer has a pumping plant with a capacity of 1,000 gal. per minute he can reasonably expect to irrigate 100 to 200 acres of land. While theoretically this is 5 to 10 gal. per minute per acre, it is always necessary to have a certain amount of head to cover the land, and it would be very difficult and tedious to irrigate 5 acres with a flow of 50 gal. per minute.

Sandy land will require about twice as much water as will heavy land. The ability of the irrigator can easily make 100 per cent difference in amount of water required. The preparation of land and the method used to distribute the water are the factors which make irrigation a success or a failure, financially. Usually, however, the larger the capacity of the plant the more benefit the farmer will receive from the water. More than twice as much land can be irrigated with a flow of 1,000 gal. per minute than would be possible with a flow of 500 gal. per minute.

**Power for Pumping.**—The type of fuel which the farmer should use will depend somewhat on the size of the installation. For small installations of from 3 to 10 h. p., kerosene probably is the most reliable fuel. For installations of 3 h. p. or less, it probably would be more economical to use gasoline.

For engine of 15 h. p. or greater, quite generally it is found economical to use a distillate oil for fuel. Distillate may be secured at prices varying from 5 to 10 ct. per gallon. The amount of power developed by 1 gal. of distillate is practically the same as that developed from 1 gal. of gasoline, and it is possible to make quite a saving in fuel cost by installing engines which are equipped to use this character of oil. Engines burning distillate, however, require more or less attendance, and for this reason it is perhaps not so well adapted to engines of small horsepower.

**Cost of Plant.**—The cost of the completed pumping plant will vary from $60 to $100 per horsepower. The larger the plant the less the cost per horsepower. Specific costs cannot be given, for the reason that local conditions will determine the character and type of the well and the kind of machinery to be installed.

A pumping plant having a capacity of 750 gal. per minute is large enough to irrigate an 80-acre tract in the Arkansas river valley if the distance to water is 20 ft. In other words, a No. 5 single-stage, centrifugal pump would be necessary for this work. The "draw down" in the well probably would be about 20 ft., or the total lift for a plant of this size probably would be in the neighborhood of 40 feet. To operate the plant at its fullest capacity a 25-hp. oil-burning engine would be required. The probable cost of the engine, installed, would be approximately $1,000. The cost of the pump and piping, complete and in place, would be approximately $250. This would make a total machinery cost of $1,250, not including the housing of the engine and well. The well probably should have a depth of 60 ft., and if constructed by local labor the total cost per foot would be about $4.50, which would make the total cost of the well $270. The engine house and other accessories, including oil tank, belting, etc., perhaps would cost $330. Adding $150 for incidental and other expenses will make the total cost of the plant, complete and in place, approximately $2,000. This would be a cost of $25 per acre, or $80 per horsepower required for a plant of this size.

This perhaps is a fair example of the cost of pumping plants in the Arkansas River Valley. It is probable, however, that with a flow of 750 gal. per minute a farmer could irrigate more than 80 acres of land if proper methods of application were used. No pumping plant should be considered complete until it is properly housed and protected from the weather.

**Cost of Operation.**—An engine will consume about one-eighth of a gallon per horsepower per hour. That is, a 25-hp. engine will consume about 3 gal. of oil per hour. If this should be distillate fuel, the cost would be about 20 ct. per hour. Lubricating oil probably would cost 3 ct. per hour, making a total fuel cost of about 23 ct. per hour for a 25-hp. engine.

Attendance to plant will vary with the size of the engine. The larger the engine the more attendance will be required. For a 25-hp. engine the cost of attendance probably would amount to about 10 ct. per hour.

In general, depreciation can be figured at approximately 10 per cent per annum.

Interest on the investment will vary with the locality, but probably will be about 8 per cent per annum. It is readily seen that two very important items in the cost of water are the interest on the investment, and the depreciation in the plant. Each of these will be practically equal to the fuel cost, but this will depend more or less upon the number of days the plant is operated. Under average conditions, figuring on a basis of 90 days' pumping, the fuel cost will vary from 3 ct. to 5 ct. per acre foot of water per foot of lift. The depreciation will be equivalent to the same amount, and interest on the investment probably will be equal to the fuel cost, making the total cost of water about 9 ct. to 15 ct. per acre foot per foot of lift.

Applying these figures to a 40-ft. lift, the cost of enough water to cover an acre of land 12 in. deep would vary from $3.60 to $6. For a single irrigation 4 to 6 in. of water would be required. On a basis of 4 in. per irrigation, 1 acre foot would cover 3 acres of land, and the cost per irrigation would vary from $1.20 to $2. In many cases only fuel costs are considered. The cost of a 4-in. irigation with a 25-hp. engine, operating a No. 5 pump with the 40-ft. lift, under first-class operating conditions, would be about $1.50 per acre.

## Rules for Operation of Imhoff Tanks

The following rules for operation of Imhoff tanks are taken from the report of the Committee of Sanitation of the Minnesota Surveyors' and Engineers' Society, submitted at the last annual meeting of the society:

Any material, other than sand and grit, which may collect in the inlet chamber, should be forced through the opening into the settling chamber. Sand and grit should be removed and deposited upon the surface of the ground. The inlet chamber should be kept clean at all times. Any material which rises to the surface of the sewage in the settling chamber which does not sink readily when broken up, should be removed to the vents. Any sludge which deposits on the walls of the settling chamber should be forced through the slots into the sludge chamber. The walls of this chamber can be kept clean by daily scraping and forcing any adhering deposits through the slots. This can be accomplished by using the device shown on the appended blueprint.

Any scum which collects on the surface of the sewage in the vents should be thoroughly stirred up daily, so as to liberate the entrained gases and facilitate the settling of the solid material. If the scum in the vents should reach a thickness of over 6 in. a portion of it should be removed. The surface of the sludge in the sludge chamber should never be allowed to reach a point higher than 2 ft. below the slots, equivalent to a point about 9 ft. below the surface of the sewage. The level of the sludge in the sludge chamber should be lowered about 2 ft. each time the sludge is removed, except in the late fall, when about 4 ft. should be removed, to allow for the winter's accumulation. The operator should be provided with a sampling outfit by means of which bottle samples of sewage in the sludge chamber can be collected at various depths and the exact location of the surface of the sludge determined.

The surface of the sludge should be determined at least once every two weeks.

Ice which may collect on the surface of the sewage in the settling and vent chambers should be removed immediately.

When the sludge on the drying bed reaches a depth of about 1 ft., it should be removed. Since a portion of the sand will adhere to the sludge removed from the bed, it will be necessary to replace the top layer of sand on the bed from time to time.

# Fertilizing Value of Activated Sludge

In December, 1915, a small experimental activated sludge plant was placed in operation at the main sewage disposal works of Toronto, Ont. Tests of the fertilizing value of the sludge produced at the plant have been made by George G. Nasmith and G. P. McKay of the Department of Public Health, Division of Laboratories. The results are described by Messrs. Nasmith and McKay in a recent issue of the Journal of Industrial and Engineering Chemistry, to which we are indebted for the matter in this article.

**Preparation of Experimental Plot.**—The fertilizing value of manure was taken as the standard of comparison for the tests. No attempt was made to compare the value of sludge with commercial fertilizers on a nitrogen, phosphoric acid or potash basis. The real single, final test of any fertilizer or manure is the increase in the yield produced by it when compared with an equivalent amount of barnyard manure.

For the plot experments a site was selected on very poor, humus-free clay soil, adjacent to the experimental plant. The surface was scraped to free it of any organic matter present, and 4 in. of water-washed sand were then thoroughly incorporated with the soil to a depth of 10 in. This was done to permit of aeration, to prevent the soil baking in the sun, and to make the soil friable.

Six beds, each 10 ft. x 4 ft., were then laid out and separated from the paths by boards placed edgewise in the ground.

One bed was kept as a control, and no fertilizer added to it. The second was treated with 27 lb. of air-dried horse manure, and the other four each with 27 lb. of air-dried sludge (equivalent to 14½ tons to the acre). This is summarized below:

| Bed | Air-dried fertilizer | Quantity used Lb. | Total nitrogen Per cent. | Total P₂O₅ Per cent. |
|---|---|---|---|---|
| No. 1 | None | 0 | [illegible] | [illegible] |
| No. 2 | Manure | 27 | [illegible] | [illegible] |
| No. 3 | Activated sludge | 27 | [illegible] | [illegible] |
| No. 4 | Sludge from old [illegible] | 27 | [illegible] | [illegible] |
| No. 5 | Humus—brush filter | 27 | [illegible] | [illegible] |
| No. 6. | Sludge—tanks | 27 | 1.21 | 1.24 |

**Planting and Care of Crop.**—On May 18, 1917, the fertilizers were added and thoroughly incorporated with the soil, and on May 21, the seeds were planted in all the beds. Seeds were used except in the case of tomatoes and Spanish onions. A fairly thick planting was made so that plenty of seedlings would be available when thinning out, and a uniform number of strong seedlings of each variety could be left in each bed.

As each row of vegetables was pulled from the several beds at the same time, the complete plants leaves and all, were placed in bags, labeled and brought to the laboratory. After the removal of adherent earth the product of each bed was weighed; the tops, in the case of root crops, were then taken off and weighed separately and the difference taken as the weight of the root. Notes were also made as to the quality of the crop.

Before weighing, the crops were spread out on the floor in their respective groups and photographed. The photographs, however, gave only a general idea of the difference in size of the various groups because of the fact that the camera had to be tilted, in consequence of which the rows closer to the camera appear larger and the rows farther away smaller than they should be.

The plan adopted worked very well in practice and gave, it is thought, fair comparative results.

Daily observations were made by the man who looked after the beds, and who was himself a gardener, as to appearance of the various vegetables, temperature, rainfall and cultivation. When he cultivated one bed he cultivated all the beds; if he watered one he watered all, and used the same amount of water, and when he pulled one variety he pulled that variety from all the beds.

In this way an attempt was made to eliminate every factor which might give any advantage to one bed over another, and to remove every influence that might have had any bearing on the growth of the plants except the actual effect of the fertilizers themselves during the course of one season.

**Synopses of Results.**—The following are synopses of the results obtained:

TABLE 1—[illegible]

| | | | | | | |
|---|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Increase in roots over control—per cent | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Yield per acre—tons | | [illegible] | [illegible] | | | |

TABLE 2—[illegible]

| | | | | | | |
|---|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | | | |
| [illegible] | | | [illegible] | | | |
| Yield per acre—tons | | [illegible] | [illegible] | | | |

TABLE 3—LETTUCE, GRAND RAPIDS.

| | | | | | | |
|---|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Yield per acre—tons | [illegible] | | | | | |

[illegible]

TABLE 4—BEANS

| | | | | | | |
|---|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Increase over control—per cent | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Yield per acre—tons | 1.78 | 3.16 | ... | | | |

TABLE 5—[illegible]

| | | | | | | |
|---|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Increase over control—per cent | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Yield per acre—tons | 5.85 | 13.90 | ... | ... | ... | ... |

TABLE 6—LATE RADISHES

| | | | | | | |
|---|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Increase over control—per cent | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | | | | | | |

TABLE 7—TOMATOES

| | | | | | | |
|---|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Increase over control—per cent | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | | [illegible] | [illegible] | | | |

TABLE 8—CARROTS.

| | | | | | | |
|---|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | | | | | | [illegible] |

TABLE 9—ONIONS, SPANISH (16 BEST)

| | | | | | | |
|---|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | | | [illegible] | | | [illegible] |

TABLE 10—[illegible]

| | | | | | | |
|---|---|---|---|---|---|---|
| [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | | [illegible] | [illegible] | | | [illegible] |

TABLE 11—[illegible]

| | | | | | | |
|---|---|---|---|---|---|---|
| [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | | [illegible] | [illegible] | | | |

**Results Indicate that Activated Sludge is the Most Reliable Fertilizer.**—From the foregoing tabulated results it is clearly evident that activated sludge is a most valuable fertilizer. When compared with the standard barnyard manure used by the farmer, the results show the following increases:

[illegible]

| | Per cent. |
|---|---|
| Radishes | [illegible] |
| Lettuce | [illegible] |
| Beans | [illegible] |
| Beets | [illegible] |
| [illegible] | [illegible] |
| [illegible] | |
| [illegible] | |
| [illegible] | |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |

From the results obtained it seems to be true that crops such as lettuce, where the foliage itself is eaten, or crops like beans, beets or tomatoes, which demand a heavy growth of plant and leaf if the yield of roots or fruit is to be heavy, can be stimulated into very heavy growth by the use of activated sludge. The increase in the yield of onions is also great.

For the growth of lettuce or tomatoes under glass, activated sludge should, therefore, prove to be a most valuable fertilizer. In the case of radishes, though the final weight was not materially greater, the radishes matured much more rapidly, which is just as valuable to the market gardener as if his crop were greater, for the quick growth is what is wanted. The same holds good of lettuce or beets in which the growth was much more rapid than it was with the other fertilizers tested. These points are now being tested by actual experiments under glass.

It should be noted that the amount of air-dried manure added, 14½ tons per acre, is about the maximum amount that could be used to advantage, and, therefore, in all probability the maximum crops capable of being produced by the addition of manure had been produced.

If this is true then the increase in yield due to activated sludge over ordinary barnyard manure is very striking and at once places a high monetary value on this material, for the value of fertilizers must be directly proportional to the crop returns yielded by them.

## Cost of Thawing Water Services with Electricity

At the recent convention of the American Water Works Association considerable information regarding last winter's experiences with frozen water services was brought out in the discussions. The costs of electrically thawing services in several of the cities are shown in the following table:

| | Per service. | Remarks. |
|---|---|---|
| Paterson, N. J. | $ 8.20 | Includes all expenses and overhead. |
| Madison, Wis. | 10.00 | Charge for thawing. |
| Kitchener, Ont. | 2.00 | Current 50 ct. per service. |
| Petersboro, Ont. | 2-2.50 | |
| Niagara Falls, Ont. | 10.00 | Charge by electric company. |
| Green Bay, Wis. | 3.50-12 | Electric light company charged $1.50 per hour for current and $3 per hour for men. |
| New Rochelle, N. Y. | 15.00 | Charge by electric light company. |
| Trenton, N. J. | 7.50 | Water Department. |
| Gary, Ind. | 3.00 | By city; electric light company charged $10. |
| Lawrence, Kan. | 3.25 | Current 10 ct. per hour; 1 man at 60 ct., 1 man at 35 ct. and 1 man at 25 ct. |
| St. Louis County, Missouri | 6.58 | Current $1 per connection and 75 ct. per hour for man. |
| Minneapolis, Minn. | 5.00 | City outfit. |

**Average Rainfall for 50-Year Period.**—The average yearly rainfall at Fitchburg, Mass., for a 50-year period has been 41.71 in., according to the last annual report of the Board of Water Commissioners of that city.

**Cost of Installing Meters on Old Services.**—The cost of labor and material for installing meters on old services at Louisville, Ky., in 1917, according to last annual report of the Board of Water Works, was as follows:

| Size. In. | No. | Cost per meter. |
|---|---|---|
| ⅝ | 21 | $0.62 |
| ¾ | 3 | .77 |
| 1 | 9 | 1.01 |
| 1½ | 1 | 1.95 |
| 2 | 7 | .54 |

Of the total cost of $30.87 for installing the meters, $29.95 was for labor and 92 ct. for material.

## Plant Extensions of Public Utilities Financially Considered

By J. W. LEDOUX.

At the New Orleans meeting of the American Water Works Association in 1910, the writer presented a short paper calling attention among other things to the danger of putting in water works extensions without adequate returns. Since that time there is good reason to believe that this subject has been receiving careful attention by many water works engineers and superintendents.

In past years it was common practice for the water works management to install at its own expense an extension where the revenue in sight did not exceed 10 per cent of the cost of the extension. It is the opinion of the writer that under ordinary circumstances it does not pay to lay a water works distributing pipe extension unless the annual revenue obtainable thereon is considerable over 25 per cent of the cost.

An examination of the statistics of privately owned water works plants in the United States shows that the distribution piping system upon which consumers are located will cost from 25 to 65 per cent of the cost of the entire works; 45 per cent representing probably a fair average. They show also that the entire cost of operation, not including depreciation, will generally range between 3 and 7½ per cent of the cost, a fair average being about 4½ per cent. This cost of operation will also be seen to range between 25 and 75 per cent of the gross revenue, a fair average being about 45 per cent.

In these respects every water works has its own particular characteristics. For many gravity plants, as well as advantageously located pumping plants, the operating expenses, when considered as a percentage of the cost of the plant or of the gross revenue, are comparatively low.

The relative cost of the distribution system will depend largely on the number of consumers per mile of distribution pipe and the adequacy of the fire protection.

If a demand were made upon the water works management to lay a pipe extension at a given location, the first consideration would be whether the pipe would be used for domestic and industrial use, fire service or both. If the former, a large quantity of water will be consumed. If for fire service scarcely any water will be consumed, so that at first sight it would seem that much less percentage of return on the cost of the extension will be required if the service is to be entirely for fire protection than if for water consumption, for the latter taxes the entire plant, while the former generally taxes only the distributing system. However, it is believed that it is not necessary to make any such distinction, except in special or unusual cases. Reasons for not making distinction between the two classes of service are becoming more apparent when it is considered that the modern tendency is to make the principal charge for fire protection an annual payment of a fixed sum per foot or mile of distributing pipe.

Let us assume that for a particular water works system the cost is $1,000,000, the cost of the distributing system is 45 per cent, or $450,000, the gross revenue is $135,000, and the operating expenses $45,000. Let us assume a fair allowance for depreciation will be 1 per cent, or $10,000. The net revenue will then be $135,000 — ($45,000 + $10,000) = $80,000, which is 8 per cent of the cost of the works.

Now let us assume a demand is made for a pipe extension, on which there can be counted with reasonable certainty a revenue of $135 per annum. A reliable estimate shows the cost of the extension will be $450. The revenue attainable will be from average consumers as well as the regular proportion for fire protection. Under these circumstances we can calculate the rate of return as follows: If the distributing system costs 45 per cent of the entire cost of the system, there must be added to the balance of the system, either before, at the time or after the installation of this extension, $556 worth of non-revenue-producing plant, if we wish to maintain the entire works in its standard condition. According to logical accounting methods the revenue-producing part of the plant must earn sufficient to pay the required rate of return on both it and the necessary non-revenue-producing part of the plant.

In other words, every time a distributing pipe extension is laid there must be furnished an adequate portion of a new reservoir, filter plant, pumping engine, boiler plant, building, force main, etc.; and there must be sufficient return to pay for all these things; otherwise when required there is no financial means of obtaining them.

Every factory manager who has given the subject of scientific cost keeping any consideration knows that this principle is fundamental: The producing part of the organization must earn sufficient to pay all charges, including the upkeep of the non-producing part of the organization. All this is usually lumped under the title of "Overhead" charges.

| | |
|---|---|
| We therefore have cost of extension | $ [illegible] |
| Cost chargeable to balance of plant | [illegible] |
| Total cost | $1,0[illegible] |
| Operating expenses, [illegible] per cent | [illegible] |
| Depreciation, 1 per cent | 10.00 |
| Return, 7 per cent on cost | [illegible] |
| Gross revenue required to maintain 8 per cent on return | $ [illegible] |

The extension itself will then have to pay—

$$\frac{135}{450} 100 = 30 \text{ per cent.}$$

A simple formula universally applicable is—

$$X = \frac{(O + R + D)}{P} 100 \quad (A)$$

in which

[illegible]

Another formula of somewhat more general application is as follows:

$$X = \$10{,}000 \frac{R + D}{P (100 - M)} \quad (B)$$

in which all the terms have the same designation as before, and M = per cent operating expenses is of gross revenue.

Tables I and II are calculated from formulas A and B, assuming the rate of return is 7 per cent and the depreciation 1 per cent on the total cost.

It is evident this method can be used for gas and electric light and power plants, and in fact the principle applies to operation of many kinds. Obviously for the term "Cost" the appraised "Valuation" can readily be substituted.

According to this discussion as the operating expenses are likely to be between 35 and 55 per cent of the gross revenue, and the cost of the extensions is likely to be between 40 and 55 per cent of the entire cost of the plant; if the net earnings are to be maintained above 7 per cent plus depreciation then it is not warrantable to install an extension unless said extension will earn from 22 to 44 per cent of the cost thereof.

TABLE I.

| O<br>Per cent operating expenses is of total cost of water works. | Per cent distributing system costs of total cost. P — Per cent of gross revenue required from cost of extension alone assuming 7 per cent return and 1 per cent depreciation. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 4.5 | 50 | 42 | 36 | 31 | 28 | 25 | 23 | 21 | 19 |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 5.5 | 54 | 45 | 39 | 34 | 30 | 27 | 25 | 23 | 21 |
| 6.0 | 56 | 47 | 40 | 35 | 31 | 28 | 25 | 23 | 22 |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

TABLE II.

| M<br>[illegible] | Per cent distributing system costs of total cost. P — [illegible] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

## Cost of Pumping at Louisville, Ky.

The operating expenses of the water works of Louisville, Ky., for 1917 showed an increase of over $48,000 over those of the previous year. This unusual increase, states the last annual report of the Board of Works, was due to the higher cost of fuel supplies, chemicals and labor and an increase of 20 per cent more water pumped than in the year previous. The cost of fuel increased 200 per cent, the cost of chemicals increased 32 per cent, the cost of labor increased 50 per cent.

The cost of pumping at the River Station was nearly 100 per cent higher in 1917 than in 1916; at the Crescent Hill pumping station the cost was about 20 per cent greater. The first mentioned station has three pumps, a centrifugal which operated 21 days and pumped 307,080,000 gal., a Leavitt which operated 364 days and pumped 4,839,869,000 gal. and an Allis-Chalmers, which operated 305 days and pumped 7,476,390,000 gal.

The Crescent Hill station has three Holly pumps. The total pumpage for the year at this station amounted to 10,537,662,000 gal.

The following tables show the operating costs of the pumping stations for the years 1914, 1915, 1916 and 1917:

| | [illegible]<br>Per [illegible] | [illegible]<br>Per [illegible] | [illegible]<br>Per [illegible] | [illegible]<br>Per [illegible] |
|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Supplies | ... | .06 | .04 | .07 |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Total | [illegible] | [illegible] | $2.71 | [illegible] |

[illegible]

| | 1917<br>[illegible]<br>mill. gal. | 1916<br>[illegible] | 191[illegible]<br>[illegible] | 191[illegible]<br>[illegible] |
|---|---|---|---|---|
| [illegible] | [illegible] | $1.70 | [illegible] | $1.7[illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Supplies | [illegible] | .06 | [illegible] | [illegible] |
| Repairs | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Total | [illegible] | [illegible] | [illegible] | [illegible] |

[illegible] gal. pumped.

# The New Sewage Treatment Plant of Sedalia, Mo.

By R. E. McDONNELL.

Sedalia is a city of nearly 20,000 population located in the west central portion of Missouri. It is principally a residential city, and has very few manufacturing enterprises; however, the Missouri Pacific and Missouri, Kansas & Texas Railroads have large shops located there. It is in the midst of a rich agricultural district and serves as a market outlet for this territory.

About 8 years ago the city constructed a sewage treatment plant consisting of septic tanks and single contact beds, with a capacity of about 100,000 gal. per day to serve the southeast portion of the city. This method of treatment was adopted on account of the low head available for a gravity plant, and has proved very economical and satisfactory for the local conditions. The septic tanks were provided with sludge drains and advantage has been taken of times of high water in the creek to flush out the deposits so that the tanks have never required cleaning.

The sewage from the northwest portion of the city was long emptied without treatment into a creek on that side of the city. In 1895 a farmer above whose land this outlet was located began legal action against the city to secure damages and prevent the pollution of the stream. From this time on the case was continually in the courts for over 20 years. The case was tried four times in lower courts and each time was appealed to the Supreme Court, by which it was remanded three times for new trial, in the lower court; change of venue was also secured twice. One count was finally decided by the Supreme Court, but the second count never was settled. A few years ago the farmer who brought the suits died, and the estate made a proposition to the city to donate 3 acres of land on the farm to be used as a site for a modern up-to-date sewage treatment plant, and agreed to dismiss the suit in the courts. The result of this proposal was that the city engaged engineers to design such a plant. It is probably safe to say that during the prolonged litigation in the courts the city spent one-third or more of what a treatment plant would have cost.

The district from which the sewage is treated in the northwest plant comprises practically all the commercial and industrial portion of the city, and a considerable portion of the residential portion, with an area of approximately 240 acres, most of which is closely bult up.

The sewer system is a combined system receiving both sanitary and storm sewage. The dry weather flow was intercepted at the outlet of the brick sewer and carried on down the creek through a 24-in. pipe to the treatment plant. Weir measurement of the dry weather flow taken continuously for three days indicated an average flow of about 850,000 gal. per day, but a yearly average was estimated to be around 1,000,000 gal. per day. The plant was designed for a total capacity of 1,500,000 gal. per day in order to provide for the possible increase during a period of 10 to 15 years.

Since the final effluent was to be discharged into a small stream having very little flow during dry periods, the type of plant selected was such as to prevent unsightly deposits, pollution of stream by decomposing matter, and injury of water for stock purposes. The plant as constructed consists of an interceptor and grit chamber, Imhoff tanks, sludge beds, dosing tank, and sprinkling filters.

Since the sewer system is a combined system and the treatment plant is designed for the sanitary sewage only, a combined intercepting and grit chamber is provided so that the operation of the plant will not be interfered with by a great inflow of storm water during rainy periods and by the collection of sand and gravel in the Imhoff tanks. The entrance chamber contains two weirs so that when the flow exceeds the rated capacity of the plant the surplus will overflow the second weir and pass directly to the stream. The sewage passing the first weir enters a grit-chamber 20 ft. long and 8 ft. 6 in. wide with hopper-shaped bottom, so that the velocity is reduced to approximately 1 ft. per second, allowing the heavier street washings to settle. These deposits can be periodically removed, or flushed out into the bypass. A bar screen with ½-in. openings is provided in the outlet from the grit chamber to intercept the largest floating and suspended matter.

The Imhoff tanks are rectangular in form and divided into two separate tanks so that either one can be put out of use at will. Each tank is 73 ft. long, 25 ft. wide and 21 ft. 6 in. deep from surface of sewage to bottom of sludge chamber. The capacity of the flowing-through chambers is designed for a 2-hour retention period on the basis of the average flow. Each tank has a bottom consisting of five hoppers each 14 ft. square at the top, 2 ft. at the bottom and 3 ft. 6 in. deep. The sludge chambers have a combined capacity of 15,220 cu. ft. figuring up to 1 ft. below the slot. The gas vent is formed by a continuation of the hopper walls and is 2 ft. wide, and 3 ft. above the sewage level extending the entire length of the tank. Equalizing parts are provided across the gas vents at each end to prevent any tendency of fresh sewage stirring up digested sludge due to unequal flow and head on weirs.

General View of Sedalia, Mo., Sewage Treatment Plant.

The sewage enters the inlet channel at one end, and flows over eight weirs 30 in. wide into the tanks, and passes out over eight similar weirs of removable iron plates into the outlet channel. The inflow will be about 6 in. deep allowing floating material to pass, and when reversal of flow is desired the iron plates can be transferred from the outlet weirs to the opposite end and the sewage will then flow through channels around the outside of the tanks. Scum walls extending 18 in. below the sewage surface are provided at each end of the tanks to retain floating matter.

Each sludge chamber is provided with an 8-in. cast iron sludge draw-off pipe, through which sludge is withdrawn under a hydrostatic head of 4 ft. 6 in. below the sewage level. The base of this sludge pipe is enlarged by a 16x18-in, reducer and the top is carried up vertically to the top of the gas vent. Gate valves are provided on each sludge pipe just outside the Imhoff tanks, and the remainder of the lines is vitrified pipe.

The sludge flows to two sludge drying beds each 73 ft. long and 20 ft. wide, the inlet pipes being 18 in. above the surface of the beds. These beds are located parallel to the Imhoff tanks, one on each side and 5 and 10 ft. away, respectively, and are enclosed in vertical concrete walls varying in height from 2 ft. 6 in. to 8 ft. 6 in. above the footings to conform to the final fill around the plant. The filtering material consists of 6 in. of sand over a layer of gravel varying in thickness up to 6 in. over the top of the underdrains which consist of three lines of 6 in. drain tile laid 6 ft. apart and draining into the main by-pass around the plant. The bottom of the beds was graded so as to slope 6 in. toward the drains. The capacity of the beds was proportioned on the basis of a four months' storage in the tank figuring .0035 cu. ft. sludge per capita per day for 10,000 population, and a depth of 18 in. on the sludge beds.

The effluent from the Imhoff tanks flows through an 18-in. pipe to a covered tapered dosing tank 15 ft. square on top and 9 ft. x 3 ft. at the bottom and 6 ft. 10 in. deep inside. An 18-in. siphon with a drawing depth of 4 ft. 6 in. is set in the floor of this tank and automatically discharges the contents of the tank to the amount of 7,000 gal. about every 10 minutes through a 24-in. sewer encased in concrete to the sprinkling filters.

The sprinkling filters have an area of about 0.6 acre and are 184 ft. long and 146 ft. wide, the width being controlled by the topography of the ground. The filters are designed to operate at the rate of 2,500,000 gal. per day, with an average depth of rock of 5½ ft. and varying in size from 1 to 2½ in. The limestone rock for the filters and also for concrete aggregate was obtained from a quarry in the hillside about 200 ft. away.

The floor of the filters is of plain concrete, 4 in. thick, over which 6-in. split drain tile underdrains are laid 7½ in. center to center and on a slope of 1:50 toward the two main drains. The walls of the filters are 6 in. thick at the top, 8 in. at the bottom and 6 ft. 6 in. high, not designed to be self-supporting, but only to separate the earth and stone, hence requiring equal fill outside and inside during construction.

The main distributor is of 24-in. vitrified pipe, and the laterals of 8-in. vitrified pipe, both encased in concrete. Each lateral is controlled by an 8-in. gate valve near the main. Three-inch galvanized pipe is used for the risers and distribution is effected through 252 Taylor square spray sewage nozzles spaced 10 ft. centers. The main drains are of 15-in. split sewer pipe. The bed is ventilated by means of 8-in. sewer pipe risers surmounted by one-quarter bends, there being 110 vents in all, partly over the box vent changer at the upper ends of the lateral drains and partly over the main drain.

Provision is made for by-passing the entire plant or the filters only. Final discharge of the effluent from the plant is into the creek only a few feet from the filters. The total head from the invert of the sewer entering the intercepting chamber to the lower end of the main drain from the filters is 14 ft. 8 in.

The contract for the construction of the plant was let in November, 1916, to J. W. Menefee of Sedalia for $50,000, and the plant was completed in the fall of 1917. The plans were prepared by Burns & McDonnell, Consulting Engineers, Kansas City, Mo., who also drew the plans for the southeast plant, and the construction work was supervised by F. T. Leaming, City Engineer of Sedalia. The average cost of the various parts of the plant per 1,000,000 gal. capacity was as follows:

| | |
|---|---|
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |

## Manufacturing Company Furnishes Employees With Land For Gardens

A large manufacturing company having two plants at Middleton, O., set aside last year some 200 acres for gardens for its employes. The land was divided into lots 50x150 ft., making 640 garden plots in all. All of the 640 gardens were actually cultivated and it is estimated that vegetables valued at $30,000, or $50 worth per garden, were raised. The company employed an agricultural college graduate to advise the men.

**New Water Rates of St. Louis, Mo.**—A new water rate schedule that will greatly simplify bookkeeping for the Water Department of St. Louis, Mo., has just been placed in effect. Under this schedule the 100 or so divisions in the sliding scale of meter rates for general consumers has been reduced to 12. The new rates follow:

[illegible]

| | | Per 100 cu. ft. |
|---|---|---|
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| For the next | 260,000 | 8 |
| [illegible] | [illegible] | [illegible] |
| For the next | 4,000,000 | 6 |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |

[illegible]

| | | |
|---|---|---|
| For the first | 5,000 | 6 |
| [illegible] | [illegible] | [illegible] |
| For all over | 15,000 | 4½ |

**Cost of Water Main Extensions at Louisville, Ky.**—During 1917 the Board of Water Works of Louisville, Ky., constructed 19,417 lin. ft. of water main extensions, the cost being as follows:

| | [illegible] feet. | [illegible] per ft. | [illegible] per ft. | Total material [illegible] per ft. |
|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | .19 | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | 2.70 |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

Cast iron pipe cost $53 per ton f.o.b. Louisville, and Red fir wood pipe cost $1.04 per foot f.o.b. Pittsbourg, Cal.

**Distribution of Water Consumption of Oak Park.**—The daily per capita consumption in 1917 of Oak Park, Ill., a 100 per cent metered city, was 67.6 gal., distributed as follows:

| | Per capita |
|---|---|
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |

# Method for Pressure Grouting of Contraction Joints of Arch Dams

A method for pressure grouting of contraction joints in arch dams was outlined by Mr. L. R. Jorgensen in a paper* presented June 5 before the American Society of Civil Engineers. An abstract of the paper follows:

By a simple system of iron pipes (shown in Figs. 1 to 4), distributed on the face of the contraction joints, and provided with slots at certain intervals, it is possible to deliver cement grout under pressure into the space (from ¼ to ⅜ in. wide) between adjacent walls of the contraction joints, and put initial axial compression into the whole structure, thereby making it act like a solid arch.

At the same time, this grouting will greatly improve the water-tightness of the dam.

It is well known that contraction joints, even of the most efficient design, cannot be expected to be entirely water-tight. The leakage through such joints on large structures may easily amount to from 10,000 to 20,000 gal. daily, and has amounted to as much as 450,000 gal. daily. This can be eliminated by grouting the joints under pressure; still, the main purpose of this grouting is to compel the arch dam to act as an arch from the very moment the water begins to fill the reservoir.

Forcing the grout into the contraction joints, and keeping it there under pressure until it has set, presses the crown of the arch in an up-stream direction, and puts shear on the foundation in the opposite direction to that due to the water load. It seems logical, therefore, to use such a grout pressure as will force the crown up stream half the total amount of the deflection resulting from a full reservoir. In this way the maximum shearing stresses are reduced by one-half (reservoir full), the maximum cantilever stresses are reduced by one-half, and, when fully loaded, the arch compression should then be as nearly as possible in accordance with the values obtained from the simple formula:

$$\text{Unit compression} = \frac{\text{Unit water pressure} \times \text{up-stream radius}}{\text{Thickness of section}}$$

A check on the necessary grout pressure can be obtained by sighting across the crown of the arch with a transit, after first establishing the necessary benchmarks.

Great refinement in choice of final grout pressure, however, cannot be counted on, and is not essential. Considering the great influence of the temperature on the total deflection of the arch structure, it is necessary to use some judgment as to what the grout pressure should be in each case.

As a general rule, it can be stated that the grouting ought to be accomplished at a time when the structure is cold, and when the joints, therefore, have opened to their maximum extent, permitting easy access for the flow to all parts of thin grout (1 cement to 7 water to start with and thicker to finish). A large dam will generally have the least volume during March, and, therefore, the contraction joints will have opened up a maximum during this time, if the reservoir is empty.

When applying the grout pressure at such a time, it should be kept in mind that the dam body is larger at any other time, due to an increase in temperature, and that, with the cracks closed, the compression per square inch of contact surface will be increased as the temperature of the dam body increases.

Thus far only arch dams have been mentioned, but it would not require much explanation to show the advantage of tight grouted contraction joints on straight gravity dams also.

Grouting the contraction joints under pressure on straight dams throws longitudinal compression on the structure, and enables it to act as a beam at both ends, at least until the initial compression has been overcome by the beam tension. A trial calculation will prove that the factor of safety has been greatly improved, especially at the lower levels, unless the dam is very long.

The grouting of the joints naturally improves the water-tightness of the dam, and for this benefit alone, it is worth its cost. Judging from the results of analysis of leakage water through concrete dams, there are good reasons for assuming that a tight dam is going to remain safe for a longer time than a leaky one, although the writer is not attempting to predict the probable natural life of any dam.

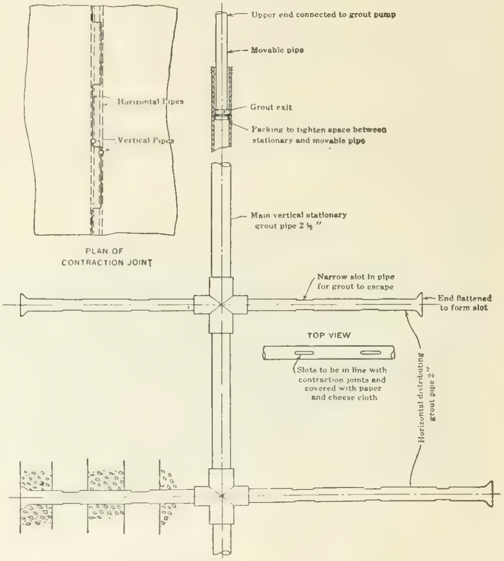
Upper end connected to grout pump
Movable pipe
Horizontal Pipes
Vertical Pipes
Grout exit
Packing to tighten space between stationary and movable pipe
Main vertical stationary grout pipe 2½"
PLAN OF CONTRACTION JOINT
Narrow slot in pipe for grout to escape
End flattened to form slot
TOP VIEW
Slots to be in line with contraction joints and covered with paper and cheese cloth
Horizontal distributing grout pipe 2"

Fig. 1.—Arrangement of Pipes for Grouting.

A straight dam which has its contraction joints grouted under pressure during the cold season, will automatically have this pressure increased during the warm season, at the rate of about 11 lb. per square inch for each degree of rise of temperature of the concrete of 1° F., as this material tries to expand and cannot. This, of course, should be allowed for, when selecting the grouting pressure for a straight dam. There could be no objection, however, to having a longitudinal compression of, say, from 200 to 300 lb. per square inch, or even more, on the concrete during the warm season.

A typical grout piping arrangement for a rather large dam section is shown by Figs 2 and 3.

On the plan of the contraction joint on Fig. 1 there are two vertical feed pipes which are desirable on a joint of the kind shown. Each vertical pipe feeds a system of horizontal pipes arranged at different levels. These horizontal pipes are provided with slots wherever they cross the open space of a joint (Fig. 1). When the pipes are put in place, these slots are covered with paper and cheesecloth to prevent the concrete from entering the pipes from the outside and blocking them. Later, when the contraction joints open, this covering will either adhere to the concrete, or the grout pressure will burst it open.

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*Improving Arch Action in Arch Dams, Proceedings Am. Soc. C. E., Vol. XLIV, No. 5, pp. 599-614.

The pipes cannot be recovered, but will remain forever buried in the dam. They are necessary, however, in order to keep the grout in a liquid condition from the time it leaves the pump until it passes through a slot very close to the desired point of deposit. The iron walls of the pipes do not absorb any of the water in the grout; the absorption, however, commences as soon as the grout leaves the exit slot in the pipe and comes in contact with the concrete walls of the joint. Therefore, this outside grout sets first and shrinks, to a large extent. The grout in the pipe system, being fluid for a long time, is able to follow up the shrinkage and fill out the cavities and keep the joint under pressure until the filler has solidified, in from ½ to 1 hour or more.

To avoid air pockets as much as possible, and otherwise to insure uniform work, the grouting should proceed from the bottom up; therefore a second, and movable, pipe is inserted in the stationary vertical pipe at the time grouting is to be done, as indicated in Fig. 1.

When starting to grout, one end of this movable pipe is to be at the bottom of the vertical pipe, the upper end being connected to the grout pump by a flexible connection. Grout is forced through the movable pipe and flows through the lower Tee, the lower horizontal pipes, and the slots in them, out into the space between the walls of the contraction joints, and rises vertically.

Before grouting commences the down-stream end of the contraction joints should be caulked (with lead wool) except for small stretches left open for exploration purposes. These are closed when the grout starts to flow out of them. The up-stream end of the contraction joints are generally provided with copper plates or other kinds of effective stops.

When the grout has reached the second story of horizontal pipes, or nearly to it, the movable pipe is raised so that the lower end is just above the Tee connection leading to those pipes. Grout is then forced into them, and, proceeding in the same manner as previously described, the crest is eventually reached. Then, finally, the pressure is kept on until the filler has thoroughly set. It is the grout pressure used on the last, or preferably on the last two joints, spaced one-third of the arch length apart, that determines the initial arch compression, and therefore on these the greatest care should be exercised.

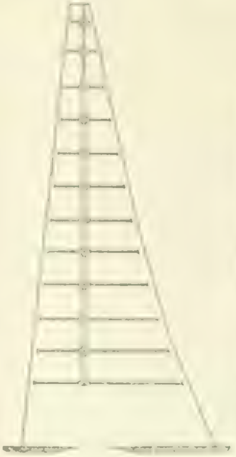

Fig. 2

Fig. 3

Fig. 4

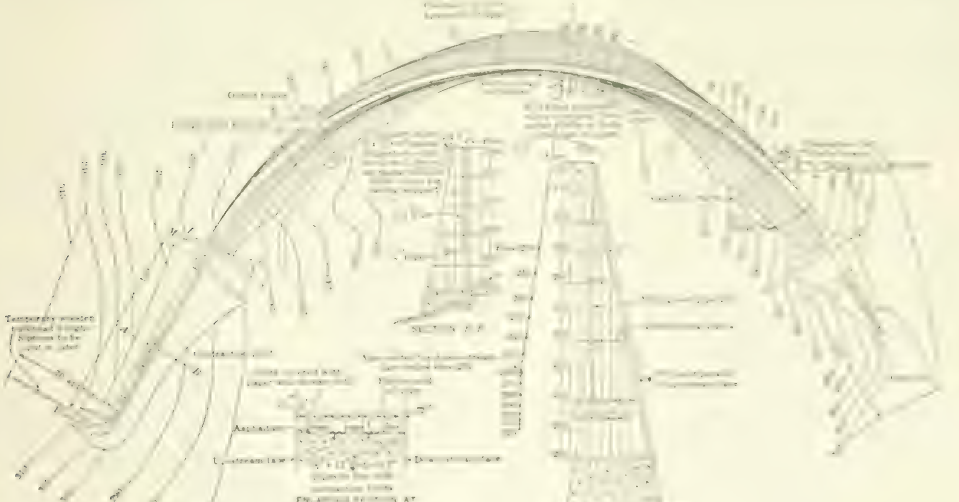

Fig. 5—Arrangement of Grout Piping for Contraction Joints of [illegible] Dam

If a dam is so large and high that it takes two or three seasons to build it, it is advisable to grout the lower third of the height at the end of the cold season, before the construction of the dam is continued; otherwise, the lateral expansion (Poisson's ratio), due to the weight of material on top, will tend to close the contraction joints. These spaces will always be narrower close to the foundation than higher up, due to shearing stresses, developed by shrinkage in the concrete close to the rock bottom, tending to prevent complete contraction.

When grouted during cold weather, an arch dam will always be under the influence of compressive stresses, and any knee in the deflection curve, due to inequalities in temperature during the construction period, will be flattened out. All told, the arch dam will act more nearly as intended, carry the load as calculated, and be more water-tight than without the grouting of the contraction joints. A straight dam will have its factor of safety increased, due to the positive beam action, and also be more water-tight.

Figs. 3 and 4 illustrate a simple arrangment of grout piping for the contraction joints of a small dam.

Fig. 5 shows what is regarded as the best arrangement of grout piping for the contraction joints of a dam of medium size (the Carroll Arch Dam). The location of these joints is indicated (not in detail, however) on this figure, which also shows the complete arch, together with the tangent spillways. The enlarged section at elevation 250 shows the details of a typical contraction joint. Only one vertical pipe is provided, and from this several stories of horizontal pipes reach all parts of the face of the jail.

The longitudinal faces of the individual recesses, making up the contraction joint, are to be made slightly tapering, so as to make sliding more certain. It should be kept in mind, however, that parallel fans will produce the greatest water tightness, and, therefore, the tapering should be very slight, only enough to take care of construction irregularities.

## Portable Steam Outfit for Thawing Hydrants

A steamer made from a 40-gal. tank mounted on a portable wood-burning furnace was used very successfully during the past winter by the Interstate Water Co., Danville, Ill., for thawing frozen hydrants. The tank had a safety valve set at low pressure and carried enough ½-in. hose to reach from the boiler to the bottom of the hydrant. It took from 5 to 25 minutes to thaw the worst cases.

**Cost of Water Mains in 1917 at Milton, Mass.**—During 1917 the Water Department of Milton, Mass., laid 890 lin. ft. of 8-in. and 3,588 lin. ft. of 6-in. water main, the unit costs of the 10 jobs ranging from $1.49 to $2.81 per foot. The average cost for the 8-in. main was as follows:

| | Total. | Per ft. |
|---|---|---|
| Labor | $718 | $0.83 |
| Teaming | 70 | .08 |
| Pipe | 884 | 1.02 |
| Other material | 375 | .43 |
| Total (870 ft.) | | $1.36 |

The average cost for the 6-in. main was as follows:

| | Total. | Per ft. |
|---|---|---|
| Labor | $2,991 | $0.83 |
| Teaming | 187 | .05 |
| Pipe | 2,396 | .67 |
| Other material | 1,177 | .33 |
| Total (3,588 ft.) | | $1.88 |

# Water Standards of Purity and Necessity of Advertising Value of Pure Water*

**Present Lack of Standards.**—A resume of legislation and the regulations of supervising health bodies indicates that the only definite technical standard that has been promulgated officially is that of the Secretary of Treasury, under date of Oct. 21, 1914, being bacteriological standard of purity for drinking water supplied to the public by common carriers in interstate commerce.

From information available, it would appear that none of the State Health Departments has officially promulgated standards of purity, either bacteriologically or chemically. In many states, legislation exists prohibiting pollution of public water supplies or the sources from which they are obtained. A few of the state health departments recognize the standards of the Treasury Department and aim to have all water supplies conform to these limits. Other state departments of health have unofficial standards which are used as a means of guidance in interpretation of water analyses, most of these being bacteriological standards only.

Reports received from 31 state health departments indicate that 13 states have laws protecting water supplies, but have not adopted any minimum chemical or bacteriological standards. Two states have laws protecting water supplies and have unofficially adopted United States Treasury standards. Nine states have laws protecting water supplies and have adopted tentative unofficial standards, while eight states have neither laws nor standards.

A resume of reports received from over 30 state health departments shows the varied interpretations placed on bacteriological analyses, and the relative importance given to sanitary survey of watersheds in conjunction with analyses.

**The U. S. Treasury Dept. Standards of Purity.**—If the standards of the United States Treasury Department must apply to all water supplies used in interstate traffic, and, if as experience has clearly shown, supplies used by railroads can conform to Treasury standards, the interesting contention is presented that all public water supplies should conform at least to this standard.

If all supplies do not measure up to this standard, the regulation works an injustice on a few supplies, and does not accomplish a general improvement in the water supplies of the country, as might otherwise be the case.

Although the United States Treasury standards are high as compared with many water supplies in this country, and although a large number of waters of our bigger and better known cities will not at all times conform to the Treasury standards, they are not high as compared with the standards existing in European countries and Great Britain.

It is appreciated that in suggesting the feasibility of adopting tentative minimum bacteriological standards, the principal objection to such procedure is the inability properly to consider the sanitary surroundings of the source of the water.

The abundant good that has been accomplished on a relatively few supplies, following the establishment of Treasury standards, however, would indicate that a considerably greater number of supplies could be improved, should minimum standards be promulgated for all of them.

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*From a paper by William J. Orchard, presented before the Chemical and Bacteriological Section of the American Water Works Association.

**Each Expert Has His Own Standard.**—Whether or not we are governed by arbitrary or tentative standards, more or less definitely fixed, those who in the course of their work are called upon to interpret large number of bacteriological analyses, unquestionably are governed by standards that they have set, upon which the interpretation is based, and this interpretation is made, first, without reference to a sanitary survey; and, second, in conjunction with a sanitary survey to determine, if possible, the sources of any apparent pollution. But these personally established water standards vary with the individual's interpretation of the analyses.

A water showing coli in 0.1 c. c. regularly will unquestionably be condemned, as will also, without doubt, a supply usually showing coli in 1 c. c.

A water showing coli frequently in 5 c. c., and occasionaly in 1 c. c., will very likely be rejected by most sanitarians, although the frequency with which such supplies are furnished to consumers, without rigorous steps being taken to improve the quality, is surprising.

When we reach a water, however, with coli present frequently in 10 c. c. quantities, and occasionally in smaller amounts, the interpretation of the analysis lies very largely with the individual, and the supply may be rejected or passed in accordance with the individual's standards.

**Uselessness of Non-Scientific Standards of Purity.**—The water standard set by the consumer is for the most part one of appearance. If a water is not turbid or colored, he is usually satisfied. Unless his immediate family has been vitally touched by the effects of an impure water supply, he is not solicitous about the quality of the supply. This matter was discussed at length by Johnson in his paper, "The Typhoid Toll," presented before this association, and was amplified in the printed discussion of that paper.

The complacent and erroneous impressions that many water consumers have in reference to their supplies must be eliminated by careful, painstaking publicity and education. In discussing water supplies of various communities with non-technical men and water consumers, one is frequently advised that the water supply is the purest in the country; that it is 99.9 per cent pure; or, that it is well water that never sees the light of day and is absolutely safe. The individual cannot be blamed for resting secure in these assertions, for he does not know better.

Most of those present at this meeting, in going into a strange city or town, do not drink the water furnished until the nature of the supply has been ascertained. Many of us abstain from drinking water when on road trips, even in territories where other liquid refreshments are not easily obtained, simply because we appreciate the pollution that a water may carry and the danger that may lurk in a tumblerful. The average consumer, however, seldom gives this matter a thought, because his training has not taught him to do so.

**Typhoid Kills More People Than the Railways.**—A more complete and masterful presentation of the value of pure water than that contained in Johnson's paper, "The Typhoid Toll," was probably never presented before any association. In it, the author says that more people are killed every year by typhoid fever than by railroads. The water consumer will stop and look before he crosses a railroad track, we must make him stop and think before he drinks a glass of water.

**The Necessity of Publicity in Marketing Pure Water.**—Mr. Johnson has shown that a pure water supply is a good dollars and cents business proposition; why not treat as such? Why not pattern our conduct as a water works association after that of a successful business organization? Are we not all of us, water works superintendents, engineers, chemists, bacteriologists, manufacturers, or what not, offering our services and our product, water, to our final customer, the consumer? Being honorable men, we want to give him the best that he will pay for, and he will only pay for the best when he is educated to its need. With the consumer educated and demanding the best in water supplies, there will be no further danger from the non-technical, disinterested, or slovenly water works vendor, for he will not be permited to do business.

Looking at this matter, then, as a business proposition, seeking to find a market for a water supply of higher standards than most of those at present furnished, should it not be approached in the same manner as any successful business campaign? Given a good product for which there is a market, the success of any business depends on bringing the product to the attention of those using it, and that can only be done by advertising and publicity. Why not have this association act as an advertising or publicity medium to obtain higher standards on the part of the technical and non-technical water works man and also the consumer? Begin with the consumer; advertise to him the value of better water so that he will demand the best, and be willing to pay for it. Then he will get it.

Are we not lacking in the fulfillment of the highest objective of this association unless we endeavor by every means at our disposal to educate the general public as to the value of pure water? Are we not stultifying the influence of Johnson's paper if we confine it, for the most part, to the technical water works man? Should we not see to it that its contents are advertised broadcast as a good business proposition?

Let us suppose that graphic illustrations of the value of pure water were to be incorporated in every public health exhibit in the country; were to be made part of traveling exhibitons; to be incorporated by the Boards of education in instructions given in school rooms, and disseminated by every educational medium. It would not be long before the demand for better water would be so insistent as to cover the entire country.

**A Suggested Committee to Advertise the Necessity of Securing Pure Water.**—And, with the objective of creating this demand on the part of the consumer, and thus offsetting the deleterious influence of the careless water vendor (and to support the technical water works man in the promulgation of higher standards of water supplies) this suggestion is offered: that this association appoint a committee to consider the feasibility of a joint board to consist of four members, one each appointed by the presidents of the American Water Works Association, the New England Water Works Association, the American Public Health Association, and the Water Works Manufacturers' Association, these four men to appoint a publicity or press agent, who might well be one of the secretaries or editors of those associations, whose sole duty would be to spread the propaganda of better water supplies. There are many problems presented; the cost of broadcast publicity at first would be prohibitive, but intensive advertising campaigns could easily be conducted in certain localities.

This is a tremendous undertaking, but unquestionably it is worth while. It is a campaign which would take years to properly cover the country, and it is not to be expected that the tangible results would be immediate. That the end to be accomplished is a good one is beyond dispute, and in aiding to spread the gospel of pure water, this association will fulfill its highest function.

## Massachusetts Experiments in Use of Ammonia with Bleach in Water Treatment

In the March 14, 1917, issue of Engineering and Contracting, Dr. Joseph Race, City Bacteriologist of Ottawa, Ont., described some experiments that he had made in the use of ammonia with hypochlorite in the sterilization of water. He found in the experimental plant at Ottawa that the amount of available chlorine required for disinfection could be reduced from about 1 part per million to about 0.25 part if 0.13 part of free ammonia was added. Preliminary laboratory experiments have been made along the same lines at the Lawrence Experimental Station and the results are given in the monthly bulletin of the Massachusetts State Board of Health.

The experiments were made in bottles using Merrimack River water. The designated amounts of bleach or the mixture of bleach and ammonia were added and tests made after 1 hour and 24 hours' contact with the chemicals. The results given in Table I show the increased effect of a given amount of bleach when half as much ammonia hydrate is added. Not enough data are as yet available to show how much the bleach may be reduced when ammonia is added and still give the same results as a given amount of bleach alone. The few results obtained indicate, states the bulletin, that it cannot be reduced as much as one-half. In experiments on the treatment of sewage, the addition of ammonia had little effect. This was to be expected as sewage contains from 5 to 10 times as much "free ammonia" as would be added with the bleach.

TABLE I - EFFECT OF USING AMMONIA WITH HYPOCHLORITE IN THE TREATMENT OF MERRIMACK RIVER WATER.

| Available chlorine (parts per million). | Ammonia (parts per million). | Time of contact (hrs.) | Bacterial per cubic centimeter. 4 days 20° C. | 24 hrs., 37° C. Total | Red. | B. Coli in .01 cubic centimeter. | .10 cubic centimeter. | 1.0 cubic centimeter. | 10 cubic centimeters. |
|---|---|---|---|---|---|---|---|---|---|
| Control | .00 | 1 | 1,400 | 360 | 50 | + | + | + | + |
| 1.00 | 00 | 1 | 22 | 14 | 1 | 0 | 0 | 0 | 0 |
| 1.00 | .50 | 1 | 7 | 4 | 0 | 0 | 0 | 0 | 0 |
| Control | .00 | 24 | 2,000 | 100 | 40 | 0 | + | + | + |
| 1.00 | .00 | 24 | 75 | 80 | 60 | 0 | 0 | 0 | 0 |
| 1.00 | .50 | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Control | .00 | 1 | 15,000 | 500 | 230 | + | + | + | + |
| 1.00 | .00 | 1 | 14 | 10 | 2 | 0 | 0 | 0 | 0 |
| 1.00 | .50 | 1 | 8 | 12 | 0 | 0 | 0 | 0 | 0 |
| Control | .00 | 24 | 1,700 | 3,400 | 1,000 | 0 | + | + | + |
| 1.00 | .00 | 24 | 6 | 18 | 8 | 0 | 0 | 0 | 0 |
| 1.00 | .50 | 24 | 1 | 7 | 2 | 0 | 0 | 0 | 0 |
| Control | .00 | 24 | 12,500 | 220 | 180 | + | + | + | + |
| 1.50 | .00 | 24 | 30 | 20 | 0 | 0 | 0 | 0 | 0 |
| 1.50 | .75 | 24 | 18 | 17 | 3 | 0 | 0 | 0 | 0 |
| Control | .00 | 1 | 25,000 | 120 | 100 | + | + | + | + |
| 1.50 | .00 | 1 | 470 | 10 | 5 | 0 | 0 | 0 | 0 |
| 1.50 | .75 | 1 | 80 | 6 | 0 | 0 | 0 | 0 | 0 |
| Control | .00 | 24 | 13,000 | 50 | 20 | + | + | + | + |
| 1.50 | .00 | 24 | 27 | 5 | 0 | 0 | 0 | 0 | 0 |
| 1.50 | .75 | 24 | 10 | 2 | 0 | 0 | 0 | 0 | 0 |

## The Dionic Tester in Water Works Service

Originally the Dionic water tester, a portable apparatus designed for the determination of the electrical conductivity of water, was devised as a rapid and reliable method of detecting leakages of cooling water into surface condensers. Several other purposes for which the apparatus has been found to be of considerable value are described by Joseph Race, City Bacteriologist and Chemist of Ottawa, Ont., in a recent issue of The Canadian Engineer, to which we are indebted for the following matter:

**Detection of Leakages from Water Mains.**—It is often desirable to determine the character of water in order to ascertain whether it is due to leakage from a water main or service, or is derived from a spring or other natural source. For this purpose the conductivity method will be found to be of great assistance when the conductivity of the public supply is materially less than that of the natural waters. The conductivity of the Ottawa supply is usually about 50 units, a unit being one reciprocal megohm, and it has been found that ground and spring waters never give a value of less than 200 units. The difference, 150 units, is so large that there is no danger of mistaking one source for the other.

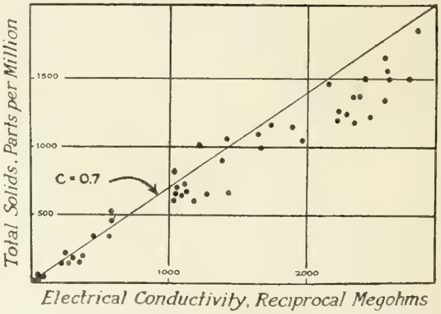

Diagram Showing Value of C for Surface and Subsurface Water of the Ottawa District.

This test, which requires only a very short time for completion, has been applied in Ottawa for several years with marked success, and has detected leakages which aggregate over 1,000,000 gal. per day. In other cases, where water was suspected to be due to leakages, the test has shown it to be ground water and has saved the cost of exploratory digging.

The only ambiguous results that have been encountered were caused by leakages traveling considerable distances and dissolving sufficient salts from the subsoil to increase appreciably the electrical conductivity. Such cases have been very small in number and do not seriously detract from the value of the method.

The Dionic water-tester is by no means to be regarded as a substitute for pitometer or aquaphone surveys, but as a complement to them. Leakages that escape to drains and fissures, and which do not appear again, can be found only by the pitometer or aquaphone. But any visible water that cannot be accounted for should be tested for conductivity and its source established.

**Estimation of Mineral Matter in Water.**—The electrical conductivity of water is caused by the presence of ionized salts in solution, and, as the great majority of the salts present in natural waters are completely ionized, the conductivity method has been proposed as a rapid way of estimating the inorganic solids. Certain German sanitarians who have experimented with this process, have stated that the mineral matter is directly proportional to the conductivity, and found that the factor c was approximately 0.7. The factor $c = m/e$, m being the mineral matter in parts per million, and e being the electrical conductivity in reciprocal megohms.

The writer has determined the value of c for a number of surface and subsurface waters of the Ottawa district, and some of the results are plotted in the accompanying diagram. It will be seen that c is by no means constant, and although the average of 70 determinations gave a value of 0.65, the variations from the mean are very considerable and invalidate the accuracy of the process as an indirect one for estimating the mineral content of water.

A similar result could be predicated from a consideration of the theoretical principles involved. The specific conductivity of an aqueous solution of an electrolyte is determined by three factors: the concentration, electrolytic dissociation, and the mobility of the ions.

The concentration is the predominating factor, but the nature of the dissolved substances also exerts an appreciable influence. Chlorides, sulphates and nitrates are practically associated completely when present in amounts up to 1,000 parts per million, but the dissociation of carbonate of lime commences to fall at a much lower concentration. At 100 parts per million the value of c for chalk is 0.40, but at 500 p.p.m. it is 0.47.

The conductivity is a function of the concentration of the ions, and also of their mobility, which is determined by the nature, the hydrogen ion being much more mobile than those of Na, K, Mg, Ca, Cl, $SO_3$ and $NO_3$, which also have different ionic velocities under a constant potential gradient.

The conductivity results are of value, however, in the classification of the source of supply, and frequent examinations of well waters have shown that there is often a correlation between the bacteriological purity and changes in the electrical conductivity. Deep wells, of great purity, have given a remarkably constant conductivity, whilst wells showing intermittent pollution have given varying conductivities. One well in Ottawa yields a water of good quality when the conductivity is about 2,000 units, and shows excessive pollution at 200 units. These results point to contamination with surface water, which gains access through a faulty casing pipe.

Wells yielding two different classes of water have been noted. One well, when the consumption is normal, supplies a chalk water having a conductivity of about 700 units; when the draft is very heavy, a saline water with a conductivity of 20,000 to 25,000 units is obtained.

**Examination of Distilled Water.**—As absolutely pure distilled water is a very poor conductor of electricity, the conductivity method is very suitable for its examination. By employing special precautions, distilled water can be prepared having a conduction of less than one unit, but the ordinary product made in laboratories will be found to have a conductivity of from 3 to 5 units. After storage in soft glass bottles, the value is usually much higher, and conductivities of 30 and over in samples obtained from pharmacists do not necessarily indicate inferior methods of preparation. A value of six should be regarded as the maximum for freshly-prepared distilled water, and if higher values are obtained, the still should be carefully examined for leakages.

# $1,500,000 California Irrigation Project Has Well Supply and 98 Miles of Steel Pipe Line

An irrigation project having several unusual engineering features was placed in service last month in Central Tulare County, California. The development was made for the Lindsay-Strathmore irrigation district, comprising 15,000 acres of land on the east side of the San Joaquin Valley. The entire area is located in the citrus belt and will be practically all devoted to the production of citrus fruits, with a small proportion of olives and other fruits. At the present time about 8,800 acres of orange and lemon orchards are in the district.

**Supply Obtained Entirely from Wells.**—The entire water supply is obtained from 37 wells. These wells have a diameter of 18 in., and an average depth of about 100 ft. and a maximum depth of over 200 ft. All of these wells penetrate many feet into a coarse and loose gravel and boulder formation. The wells for the most part are placed about ¼ of a mile apart scattered over the 1,100 acres. Regardless of what amount of water each well might be capable of delivering it is not proposed to pump in excess of 2 cu. ft. per second from each well, while the average discharge will probably be less than that amount per well. Each well is equipped with an independent pumping plant with a rated delivery of 2 cu. ft. per second against an average total head of 100 ft.

**Pumping Plants.**—These pumping plants consist of vertical turbine deep well pumps directly connected to 40-HP. vertical motors. The pumps have been furnished by the Byron Jackson Iron Works and the Layne & Bowler Corporation, and the motors by the Fairbanks Morse Co. Each pumping plant is housed in a frame building, 10x10 ft. in size, and equipped with a permanent 30-ft. derrick and movable roof so that the pumps and motors can be easily and quickly handled and removed in case of repairs. Each pump discharges into the collecting main pipes through a specially designed sandtrap, where the sand is intercepted and siphoned out of the lines.

Electric power for the operation of all of the pumping plants is purchased from the Mt. Whitney Power & Electric Co., which company delivers high voltage current to a transformer station with 1,500-HP. capacity, located on the district's property. Two thousand two hundred volt current is delivered from this transformer station to all of the wells over 9 miles of specially built power transmission lines belonging to the district. A pole top switch is provided at each pumping station, and each pumping plant is equipped with the very best type of electric control devices.

**Collecting Pipe System.**—The system of pipes required to collect the water from all of the wells and deliver it to the gravity canal consists of 87,497 ft. of 14-in. to 48-in. redwood pipe, all supplied and erected by the Redwood Manufacturing Co. The 14-in. to 24-in. pipes inclusive are spirally wound machine banded, and the 26-in. to 48-in. are of banded continuous stave construction built in place in the trench. The maximum pressure head on most of these lines is about 75 ft.

This system of pipe lines is divided into two main parts, each drawing from about one-half of the wells and delivering to the canal through independent 48-in. pipe lines, but so gated and interconnected that all of the wells can deliver through either one of the

48-in. pipes in case it becomes necessary to cut off either one of the main lines for purposes of repair. At the delivery end of the 48-in. pipe lines and before entering the forebay at the head of the low level gravity canal, all of the water delivered from the pumps passes through two 48-in. Venturi meters, provided with material recording and measuring devices, whereby the actual delivery of water from the wells to the canal may be accurately known at any time.

**Low Level Canal.**—The main pipes from the wells extend to what was formerly known as the Merryman Ditch. This ditch line was purchased and enlarged for the use of the district. The service of the old ditch was maintained by building a buried concrete pipe line ranging from 30 in. to 16 in. inside diameter throughout the length of the ditch on the outside boundary of this right of way. Through this pipe line the water of the Merryman ditch is now delivered to its consumers entirely independent of the district's canal. The Merryman ditch thus acquired and released was materially enlarged and rebuilt. The grade of the ditch is 1.98 ft. per mile, the bottom width 6.33 ft., the top width 14½ ft. and the depth 4 ft. The canal throughout was given a lining of cement mortar placed over 1½-in. mesh No. 18 galvanized chicken wire reinforcement.

This cement mortar lining was placed by means of a cement gun made by the Cement Gun Co. The cement mortar consisted of 1 part of cement to 4½ parts of coarse sand, to which was added 10 per cent of the hydrated lime. This aggregate was shot on the banks of the canal under a nozzle pressure of about 40 lb. per square inch and made a very solid and durable lining, which has been practically free from cracks of any description. By means of this method of applying the lining irregularities in the trimmed surface of the canal banks were readily overcome and economy obtained in applying the lining over rough surfaces.

At each mile throughout the length of the canal Armco Iron radial breastgates, operated by hand winches, were installed for the purpose of regulating the storage in the canal and the retarding or release of the water in the canal in the event of power shutdowns.

**Main Pumping Station.**—At the lower end of the low level canal is located the main pumping station, which delivers all of the water supplied by the well pumps through the low level canal to a sufficient elevation to provide pressure for the distributing pipe system traversing the district. The pumps in this station are supplied by gravity from a small forebay constructed at the lower end of the low level canal from which the suction pipes of the pumps are supplied.

The pumping installation installed in this station consists of three 18-in. single-stage horizontal centrifugal pumps each directly connected to 500HP. electric motors; one 12-in., single-stage horizontal centrifugal pump directly connected to a 200-HP. electric motor, and two 8-in. single-stage horizontal centrifugal pumps each directly connected to 100-HP. electric motors. The combined delivery capacity of these pumps against a total head of 162 ft. is 37,000 gal. per minute. The units are so arranged and divided that required local variations in flow of the water will be met by operating the required number of larger units for the base load, and taking the variation of flow on the smaller units. Either one of the 100-HP. units is interchangeably, automatically operated by means of a float switch and solenoid control actuated by the water level in the forebay at the lower end of the high level bench flume of a distance of about 6 miles from the pumping station. DeLaval centrifugal pumps are used in this station. The electric equipment is that of the General Electric Co. The very best and most modern type of switchboards and electrical control throughout is installed in the station.

Water from these pumps is delivered through two 36-in. riveted steel pipe lines, each with a length of 1,040 ft., to a high level bench flume. Inserted in each of these pipe lines at the pumping station is a 36-in. Venturi meter with the latest type of automatic recording registers placed in the pumping station. Each pipe line is also equipped with a pressure relief valve discharging into the low level canal to offset possible water hammer in the event of power shutdowns.

**Unusual Type of Construction for High Level Bench Flume.**—This flume has an approximate length of 6 miles. It is built of reinforced concrete and is set upon a side hill bench cut, or earth and rock fill, throughout its entire length. The grade of the flume is 5 ft. per mile and its inside dimensions are 5.75 ft. in width and 4 ft. in depth.

After very extensive study and experiment it was decided to build this conduit as a reinforced concrete flume in preference to a concrete lined canal, in excavation, the element of cost being largely the deciding factor. The type of construction adopted for the flume is an unusual one and never before attempted for this class of work. The flume has side walls 2 in. in thickness, and bottom 2½ in. in thickness, with 4x6-in. longitudinal stiffening beams at the top of each side wall tied together every 8 ft. with a steel rod set in concrete. Owing to the difficult location of the flume and the high cost of delivering materials the lightest possible type of construction was adopted, and owing to the very crooked alignment an effort was made to do away with as much form work as possible. This resulted in the building of the flume throughout, except for the longitudinal beams which were cast in box forms, with the cement gun.

**Construction of Flume with Cement Gun.**—A single form made of tongue and grooved surfaced lumber was set on the inside of each wall, and over it was placed the required reinforcement. The cement gun was then used to shoot the fine concrete aggregate, or rather coarse cement mortar, through the reinforcing material and against the inside form until it was built up to a thickness of 1½ in. and gripped the reinforcing wire. After this first coat took its initial set, so that there was no danger of sagging, the cement gun applied the finishing coat of ½ in. and left the surface with a smooth neat appearing sanded finish. The longitudinal top beams were then cast over the reinforcement and connected up to the cement gun work on the sides. Following the completion of the sides of the flume and after the removal of the inside forms the bottom was shot with the cement gun directly upon the earth of the flume bench. No expansion joints were used in the structure, which is a monolith throughout its entire length. Much of this work was put in place during the hot summer months with a maximum daily temperature in the shade on one day 123° F. and an average maximum daily temperature for one month of 112° F. The ordinary range of temperatures between night and day is about 30° with an absolute maximum seasonal range of about 90°.

The flume reinforcement was designed to take up contraction and expansion stresses for an average normal range of temperatures of 40°, although it was anticipated that, in view of the fact that the structure was so largely built during the period when all materials were at their maximum expansion, and had to face an ultimate extreme range of temperatures, there would be a certain amount of trouble from temperature cracks. Experience has shown these cracks to be less than anticipated, and to be nothing more where developed than fine hair cracks which have caused no leakage, and in which initial seepage rapidly took up due to efflorescence.

The structure throughout is perfectly tight after passing through an entire year's range of temperature and has proved an unqualified success, and it is apparently good for all time and virtually free from maintenance charges.

Six Armco iron radial breastgates are spaced throughout the length of the flume to insure storage and regulation in the event of power shut-downs. Pipe line diversions are made at various points throughout the length of the flume to supply the northern portion of the district. The fume terminates in an enlarged forebay intake at the head of the two main pipe lines which form the principal arteries of the steel pipe distributing system. As a precaution against overflow upon the valuable orchards immediately below the pipe intake forebay an automatic siphon spillway, similar to that in the forebay at the lower end of the low level canal, has been installed. This siphon spillway discharges into a 30-in. concrete pipe line 2,418 ft. in length emptying into the channel of Lewis Creek.

**Main Pipe Lines.**—There are two main pipe lines. One of these, 7¼ miles long, extends from the end of the high level canal to the southeastern corner of the district. The other pipe line extends from the lower end of the high level flume east and south for a distance of 3½ miles to the northeastern corner of the district, where it discharges into a balancing reservoir that will equalize the flow of surplus water in the flume. This line also furnishes water to the boosting station which pumps water to high level flume No. 2, supplying the high land along the eastern margin of the district. This conduit has a total length of approximately 14,500 ft., including 9,000 ft. of open concrete lined canal, with a bottom width varying from 1 ft. to 2.33 ft., side slopes of 1—1, and depths of 3 to 2 ft.; 4,000 ft. of 24-in. concrete pipe, and 1,500 ft. of 12-in. concrete pipe. From this high level canal riveted steel pipe lines draw the water for the irrigation of all of the highest land on the eastern side of the district.

**Distributing Pipe System.**—The system of distributing pipes, exclusive of the two large main pipes, consists entirely of high pressure riveted steel pipes with an aggregate length of 87.6 miles. The total length of all riveted steel lines, including the two main lines, is 98.6 miles. These lateral pipes vary in size from 4 in. to 16 in. in diameter. As a protection against the corrosive action of destructive elements in the soil, the pipe is covered throughout with a felt wrapping, which was specially prepared and applied with special wrapping machines. The wrapping consists of a heavy rag felt which is impregnated under heavy pressure with a specially prepared asphaltic compound and coated on the outside with a patented alkali resisting preparation. This felt covering is wrapped on the pipe when it is still warm from the dipping kettle and is, therefore, firmly cemented and joined to the pipe.

Pipe lines have been extended to all of the land in the district. The total length of pipe lines laid, exclusive of the two main pipes, is 162,520 ft.

**Delivery of Water to Consumers.**—All water from the distributing pipe system will be delivered to the individual irrigator through a service outlet consisting mostly of 3-in. pipe lines, leading from the lateral pipe to the property line at the side of the road. At this point a water meter is installed either of the pressure or gravity type, dependent upon the available head, for the measurement of the actual volume of water which is delivered to the land. The gravity meters were furnished by the Hydrometric Company, Los Angeles. The other meters are of the Worthington make. The system of measurement of water maintained throughout, beginning with the measurement of water through each of the main pipes by means of large Venturi meters, and the final measurement of the water from the distributing pipes through the small service meters, enables the district to know exactly at all times just what water is being developed, pumped and delivered, and the consumer pays only for the exact quantity used. A record of the duty of water is thus also accurately obtained. This accurate measurement of water not only permits of, but is absolutely necessary for the proper management of such an elaborate and extensive system of supply and delivery, and is also in line with the policy of all modern irrigation systems where provision is made for complete accurate measurement of the volume of water delivered from the pump stations into the pipes, and also from the pipes to the individual consumer, whether for irrigation or domestic use. This last feature of domestic use is one that is secondary and incidental, but nevertheless one of great convenience and value to the residents within the district and under the pipe systems.

The entire cost of the project was about $1,500,000. Stephen E. Kieffer, San Francisco, Cal., was the Chief Engineer.

**An Answer to the Arguments Against Metering.**—Arguments, if any at all, against meters are generally almost absurd. One argument is that we have an abundant supply in the ground and that water, therefore, should be as free as the air we breathe. Sure, there is plenty of water in the ground—anyone can dig a well and get it as they did in the earliest days of our city, but if you want the needed supply brought to your home under pressure, it is a little different; you must pay for the labor and transportation; complicated machinery and buildings to house same must be constructed; hundreds of miles of mains with valves and hydrants must be laid. Hundreds of tons of coal must be burned in order to obtain the necessary power to operate the pumps. Men for constructing, operating, maintaining and the repairing of the system must be hired and paid.—From the 1917 Report of the Water and Light Departments of Lincoln, Neb.

**Cost of Installing Services at Louisville, Ky.**—During 1917 the Board of Water Works of Louisville, Ky., installed 667 new services of an average length of 29 ft. The average cost of this work, according to the last annual report of the Board, was as follows:

| [illegible] | [illegible] | Cost [illegible] | [illegible] |
|---|---|---|---|
| 1 [illegible] | [illegible] | [illegible] | [illegible] |
| 1 [illegible] | [illegible] | [illegible] | [illegible] |
| 2 [illegible] | [illegible] | [illegible] | [illegible] |
| 3 [illegible] | [illegible] | [illegible] | [illegible] |
| 4 [illegible] | [illegible] | [illegible] | [illegible] |
| 6 [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | |

# Observations of California Bureau of Sanitary Engineers on Tests for B. Coli

The Bureau of Sanitary Engineering of the California State Board of Health is doing its utmost in encouraging the establishing of laboratories at water plants throughout the state. Assistance is given in the arangement, equipment and technique to be used for such laboratories. Instructions in the procedure and interpretation of analysis are given at the Bureau Laboratory maintained at Berkeley, Cal., under the direction of Mr. C. G. Gillespie, Chief Engineer.

In many cases the bacteriological work at the water plant laboratories is done by laymen and consequently the technique for the demonstration of B. coli in water supplies must be simple with a fair degree of accuracy. For the benefit of such men the Bureau of Sanitary Engineering in the June Bulletin of the State Board of Health gives the following comparison of the different steps in the demonstration of B. coli, especially in water in California.

**Method at Laboratory of State Bureau of Sanitary Engineering.**—Since the existence of the Bureau of Sanitary Engineering laboratory, September, 1915, the method for the isolation of B. coli in water samples has been that described in Standard Methods of Water Analysis as the "partially confirmed test," and consists of fermentation and enrichment in lactose broth and streaking on litmus lactose agar plates from broth tubes showing gas. The B. coli group is considered present when typical colon-like colonies develop on the litmus lactose agar plates. This method is similar to but in one particular differs from the procedure adopted by the Treasury Department on Oct. 21, 1914, for drinking water supplied to the public by common carriers in interstate commerce. The latter procedure involves an additional step over that used in this laboratory, namely: fishing and transplanting of a colon-like colony from the lactose litmus agar plates into a lactose broth tube, to confirm the gas-forming property.

**Comparison of Methods of B. Coli Tests.**—A comparison of the two methods on a large number of water samples from various sources shows the following results:

COMPARISON OF B. COLI TESTS.

| | 24 hours. | 48 hours. |
|---|---|---|
| Presumptive test— | | |
| Total number | 382 | 782 |
| Partially confirmed test— | | |
| Typical colon-like colonies | 97.1% | 76.1% |
| Treasury Department method— | | |
| Fermentation of typical colon-like colonies. | 97 % | 73.4% |

Observations were made on the presumptive test after 24 hours and 48 hours. One of the striking features of this comparison is the small number of samples showing B. coli after but 24-hour incubation and the large number of 24-hour presumptive tests which on subsequent confirmation gave positive B. coli by the Treasury Department Methods, and by the method used in the laboratory of the Bureau of Sanitary Engineering, 97 and 97.1 per cent, respectively. Of the 48-hour presumptive tests, however, only 73.4 per cent were confirmed by the Treasury Department Method and 76.1 per cent by the method of this bureau. A difference of 2.7 per cent is noted in the two methods. It is doubtful whether this difference is of sufficient importance to justify the extra work involved in obtaining the lower and doubtless more correct percentage. The "partially confirmed test" is on the safe side at any rate.

The latest Standard Methods of Water Analysis published by the American Public Health Association, 1917, defines the B. coli group as including all non-spore-forming bacilli, which grow aerobically on solid media and which produce gas in lactose broth. The B. coli tests are grouped under three headings: (1) the presumptive test, consisting only of gas production in lactose broth; (2) the partially confirmed test, consisting of plating a portion of the broth tubes showing gas on litmus lactose agar or endoes media and noting the formation of "typical colon-like colonies"; (3) the completed test, which consists of fishing typical colonies from the litmus lactose agar plates for demonstration of nonspore-forming bacilli and formation of gas in lactose broth.

It was deemed advisable to make a comparison of the three methods and determine the certainty with which the "typical colon-like colony" can be recognized and which of the three methods is most desirable for California conditions, with a view to reducing the work in the laboratory to a minimum without sacrificing the accuracy of the demonstration of B. coli. The following comparison was obtained from an entirely different series of water samples than those given in the preceding table:

COMPARISON OF B. COLI TESTS.

| | 24 hours. | 48 hours. |
|---|---|---|
| Presumptive test—total | 321 | 776 |
| Partially completed tests | 100% | 82.1% |
| Completed tests | 100% | 81.2% |

Fifty-one per cent of the tests giving confirmed presence of B. coli after 48 hours failed to indicate the presence of B. coli on 24 hours' incubation. Practically 100 per cent of the 24-hour presumptive tests were positive when confirmed by the completed test; in fact, only one sample out of a total of 321 could not be confirmed. The difference of 0.9 per cent between the "partially confirmed" and "completed test" is considered too small to warrant the large amount of time consumed in completing the confirmation.

It must be recognized that the success of the partially confirmed test depends upon one's ability to distinguish by colony appearance between B. coli and similar acid-forming colonies. On litmus lactose agar, the typical colon-like colony appears as a raised red or pink spot in a blue field, or if the field becomes acid, the red or pink color of the colony will be more prominent than that of the field. The colonies on the surface are fat, glistening and smooth with a regular outline. Small deep red colonies with a deep red or brick-colored center or irregular outline are usually not B. coli. On endo media, the colonies are raised with a regular outline, deep red and with a highly metallic sheen.

On the large number of 48-hour presumptive tests which the Bureau found negative on further confirmation, a large percentage were waters treated with chlorine gas, though the same observation applies to well waters, large reservoirs and streams. The positive presumptive tests in these cases may be attributed to either anaerobic or aerobic lactose-splitting spore-bearing bacilli, which are highly resistant to chlorine. B. welchii was isolated from the river supply at Sacramento, Cal., in 1916, as the anaerobic organism giving the presumptive test in lactose bile. At that time the city laboratory was using only the presumptive test for B. coli. In endeavoring to eliminate gas-forming bacteria from the supply, an overdose of chlorine was consequently added which caused tastes and subsequent complaints by the users of the water. More recently a larger number of aerobic spore-bearing lactose-splitting bacilli have been isolated from both chlorinated and unchlorinated supplies. It is thought that both anaerobic and aerobic spore-bearing bacteria and lactose-splitting baccili are widely distributed in California waters.

**Summary of Experiences at Bureau Laboratory.**—The experience of the Bureau on a wide range of waters has been that only about 50 per cent of the tests in which B. coli are confirmed, develop gas within 24 hours' incubation. Forty-eight hours' incubation is necessary on tubes in which gas does not develop at 24 hours. However, practically all tubes showing a gas at the end of 24 hours were later confirmed for B. coli. Of those showing gas on 48 hours incubation less than 85 per cent could be confirmed.

Samples developing gas in 48 hours in lactose broth must be fished and streaked on litmus lactose agar or endo media for further confirmation. The presence of typical colon-like colonies on the plate is for all practical purposes sufficient evidence of the presence of B. coli.

The subsequent inoculation of lactose broth tubes by such colonies and determination of the lactose-splitting property is practically unnecessary, but is advised for the inexperienced technician.

## Cost of Thawing Services with Electricity

During the past winter the Baltimore County Water & Electric Co. of Baltimore County, Maryland, thawed 332 services with electric outfits at an average cost of $10.97 per service. Three trucks were employed in this work. One truck carried the thawing equipment, consisting of thawing transformer, switches and instruments. Accompanying this truck were two linemen and one groundman from the electric company that furnished the current. The driver was an employe of the water company. Two other trucks were in service, one of them carrying the reels of wires and the other carrying the digging tools, connecting up stocks and dies for putting in short pieces if the meters were burst or damaged by the plumbers trying to thaw them. The foreman in charge of main extensions and the foreman in charge of services were employed with the thawing outfit. The total cost to the water company of thawing the 332 services was $3,641, distributed as follows:

| | Total | Per service |
|---|---|---|
| Water company labor, [illegible] hours at [illegible] | $1,[illegible] | $[illegible] |
| Water company trucks, 1,4[illegible] hours at $1 | 1,[illegible] | [illegible] |
| Current, linemen, etc. | [illegible] | 2.[illegible] |
| Total | 3,641 | $10.97 |

The water company employes were paid by the month. The figure given in the table is the average rate of wage per hour. It was necessary to excavate for some of the services. The actual cost for the excavation was $1.50 per lineal foot. We are indebted to Mr. A. E. Walden, Superintendent and Chief Engineer of the Baltimore County Water & Electric Co., for the information given above.

**Cost of Sludge Removal at Columbus, O.**—During 1917, 2,164 cu. yd. of sludge was removed from sewage treatment works of Columbus, O., at an average cost of $29\frac{1}{2}$ ct. per cubic yard, distributed as follows:

| | |
|---|---|
| Labor | [illegible] |
| Gasoline | [illegible] |
| All other expenses | [illegible] |
| Total | [illegible] |

The mean cost of labor was 33.1 ct. per hour, and the labor hours per cubic yard were 0.83. The average length of haul was 750 ft.

## Methods of Making Sewer Pipe Joints

In a topical discussion last January before the Sanitary Section of the Boston Society of Civil Engineers much interesting information was brought out on the various methods of making joints in sewer pipe. The discussion is printed in the February Journal of the Society, from which the following matter is abstracted:

**Cement Mortar Joints and Poured Joints.**—Different methods of making cement joints are: First, by the use of cement mortar alone; second, by calking a gasket, either dry or soaked in liquid cement, into the bell and then filling the bell with cement; third, by placing the cement in the joint and then calking the gasket in, thus forcing the cement into the bell; and, fourth, by the use of cement alone, forcing it thoroughly into the joint with a calking iron and covering the joint with cheesecloth for the purpose of holding the cement in place. In this latter joint small wooden blocks are imbedded in the cement of the bell for the purpose of centering the pipe.

An additional precaution to make the joints tight was used at Malden. This consisted in the use of a small wooden box having the sides cut to the radius of the outside of the pipe, which was placed at the joint and filled with cement mortar up to the middle of the sewer pipe. I used this method a number of years ago, but it did not prove entirely satisfactory.

Under poured joints may be included all of the methods of pouring the joints with hot mixtures. These mixtures are of two distinct classes, viz., that known variously as G-K, Jointite, etc., and that composed of sulphur and sand.

For making any of these joints, deep and wide socket pipe should be used. A gasket is first calked into the bell in a thorough manner, to pervent the material from running into the pipe. A gasket is then clamped around the pipe and the hot material poured in the same manner as in making water pipe joints.

Water must be kept out of the bell while the sulphur and sand joint is being poured. It is claimed that with G-K, or Jointite, this is not necessary, but from such information as I have obtained I judge it is difficult to make a good joint under water. The sulphur and sand joint becomes hard at once, but it is so rigid that the pipe will break if any settlement takes place. The G-K or Jointite compounds do not harden so quickly and have enough elasticity to take care of any slight settlement of the pipe.

In my experience, covering 30 years, I have seen three small cases of broken sewer pipe. In one case the joint was made with cement, while in the other cases sulphur and sand was used. Careful levels indicated that the breaks were not caused by a settlement of the pipe.

In order to give an idea as to the relative merits of the different methods of making joints in sewer pipes, as herein described, I will give a record of the leakage in four towns in which we measured the leakage immediately after we had built the sewers:

Easthampton, Mass., in 1893.—The joints were first calked with oakum which had been soaked in liquid cement and then filled with cement mortar. The leakage in about $1\frac{1}{4}$ miles was at the rate of 55,000 gal. per mile in 24 hours.

Andover, Mass., in 1898.—The joints were made with cement mortar, which was first placed in the

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[illegible]

bottom of the bell of the pipe. Two small wooden blocks were then placed in the cement for the purpose of centering; the spigot of the next pipe placed in position, and the remainder of the joint filled with cement mortar, calked with a calking iron, and the whole surrounded with cheesecloth. The leakage in 5.48 miles was at the rate of 5,912 gal. per mile per 24 hours.

Amesbury, Mass., in 1912.—The joints were made with sulphur and sand. The leakage in 3½ miles was at the rate of 9,700 gal. per mile per 24 hours.

Lexington, Mass., in 1915-1916.—The joints in the vitrified sewer pipe were made with sulphur and sand, and in the iron pipe with lead. Measurements were made at two points: First, at the connection of the outlet sewer with the Metropolitan sewer, and, second, at the upper end of the outlet sewer. The outlet sewer is a little over 2.6 miles in length, of which a little over one-half mile is vitrified pipe and the remainder is iron pipe. The length of sewers above the upper end of the outlet sewer is a little over 3.9 miles, and the joints were made with sulphur and sand. The leakage into the entire system of 6.56 miles as measured at the Metropolitan sewer was at the rate of 674 gal. per mile per 24 hours, and for the 3.9 miles of the system above the upper end of the outlet sewer at the rate of 71 gal. per mile per 24 hours.

Taking everything into consideration, my conclusions are that a nearer water-tight joint can be secured by pouring.

[2]**Experiences at Newton, Mass., with Sulphur-Sand Joints.**—The city of Newton, Mass., has a separate sewerage system, and for the past 11½ years a sulphur and sand compound has been used exclusively as a jointing material for its vitrified pipe, sanitary sewers and house connections, and for a limited amount of surface drains.

From June, 1906, to January, 1918, 28½ miles of vitrified pipe sanitary sewers and 31½ miles of vitrified pipe house connections have been laid with this compound of sulphur and sand. The total mileage of vitrified pipe sanitary sewers is now 118 miles, thus making 24 per cent the proportion with the sulphur compound; and the total mileage of house connections is now 98½ miles, thus making 32 per cent of the house connections laid with this material.

The size of the pipe sewers so jointed varies from 8 in. to 20 in., but 89 per cent of these sewers are 8-in. laterals. The house connections are 5 in., with a few cases of 6 in.

The method of making the joints in the pipes is similar to the pouring of lead joints in water mains. After fitting any two pipes closely together, the joint is calked with jute oakum, usually about ½ in. to 1 in. in depth, but only sufficient to prevent the jointing material from running into the interior of the pipe. A pipe jointer is then placed around the outside of the spigot end of one pipe close against the bell of the adjacent pipe, leaving a triangular opening on top of the pipe through which the joint is poured full with the molten mixture of sulphur and sand. A ladle large enough to hold sufficient material to pour the joint completely full at one operation should be used and sufficient time given for the sulphur and sand compound to harden before removing the pipe jointer. After removing the jointer, the exposed surface of the sulphur and sand mixture is painted with hot roofing pitch to close up any possible voids or slight temperature cracks. It may be questioned if this practice is an absolute necessity, but the cost per joint is slight, only about ½ ct. per joint, and is an added precaution for water tightness. The T branches provided for future house connections are closed with a stopper held in place by roofing pitch, so as to be readily removed when necessary to make a connection with a house connection.

The sulphur and sand are mixed in equal parts by measure and melted together in an iron pot held in an iron frame and suspended over a fire of waste wood. Gasoline furnaces were previously used, but owing to the increased cost of gasoline the mixture is now heated by waste wood, which is almost always to be found on a piece of sewer work. When gasoline was used for fuel for melting it required about .07 gal. of gasoline per joint.

The correct temperature to which the compound should be heated for use averages 260° F. The use of a thermometer is unnecessary after the workmen become accustomed to handling the mixture, as the correct temperature is easily ascertained by inspection. If it is too cold it will not flow properly, and if too hot the tendency is to foam in the kettle. The use of the compound does not involve any waste material, for that which is left unused in the kettle is melted the next time it is wanted and fresh material added, together with any fragments left from defective joints from leakage around the jointer in pouring the joints.

The sulphur is powdered sulphur of commercial quality, bought by the barrel. The sand is a very fine quicksand, which is obtained from a pit on the city of Newton waterworks reservation in the town of Needham. A great deal of the success of this type of joint depends on the fineness of the sand. Tests of the sand in use indicate that 90 per cent will pass a sieve having 100 meshes per linear inch and 50 per cent will pass a sieve having 200 meshes per linear inch. The pitch is ordinary roofing pitch. The jute is the usual type of tarred jute oakum. The pipe used is invariably deep and wide socket, as the annular space between the bell and spigot in standard pipe is considered too narrow for the best work.

The cost of sulphur varies from 2½ ct. per pound in 1907, to 3 ct. per pound in 1910, and 4.35 ct. per pound in 1917. The sand is charged to each piece of work at the rate of $1 per barrel of 250 lb., or 0.4 ct. per pound. The cost of the jute varies from 5½ ct. per pound in 1918 to 8½ ct. and 10 ct. per pound in 1917. The cost of the pitch varies from 1 ct. per pound in 1908 to 1.3 ct. per pound in 1917.

The quantities of material per joint required for 8-in. pipe are about as follows: Sulphur, 1½ lb.; sand, 1½ lb.; jute, ½ lb.; pitch, 0.4 lb. For 5-in. pipe the quantity of sulphur is about 0.9 lb., and other materials in proportion. On the basis of present-day prices, the cost of materials for an 8-in. joint would be from 11 ct. to 12 ct., but until recently the cost has been considerably less.

In 1907 a careful comparison was made of the cost of laying an 8-in. pipe sewer of 38 cement joints with an 8-in. sewer having 31 sulphur and sand joints. This test, which included the labor and materials for laying the pipe in both instances, showed a cost of 26.5 ct. per joint and 23.8 ct. respectively, or that the sulphur and sand joint cost 90 per cent of the cement joint.

The soil in Newton through which the sewers are laid is mostly hardpan, gravel, sand or ledge, there being but little subsoil of peat or of filling. The sewers are under constant inspection and breakages are of very infrequent occurrence, there having been but two or three breaks in the 60 miles of pipe jointed with the sulphur compound since its use was adopted from settlement of the foundation of a sewer or house connection.

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[2] From the discussion of Edwin H. Rogers, City Engineer, Newton, Mass.

Trouble is frequently encountered from tree roots on nearly all of our sewers which are laid with cement joints in which there are trees along the side of the street, and the same is true of the older house connections laid with cement joints with trees in the near proximity. We have had absolutely no trouble from the growth of tree roots in sewers or house connections laid with sulphur and sand joints.

The sewage in Newton is largely from dwelling houses, but no difficulty has been experienced with deterioration of joints from sewage from any of the comparatively few mills or factories, the sulphur and sand compound only being affected by chemicals which are most rarely found in the trade wastes from manufacturing establishments and not at all in dwelling house sewage.

**Experiences at Brookline, Mass., with Asphalt and Sand.**—We experimented with various bituminous compounds, and in 1909 used a mixture of asphalt and sand in laying a 30-in. sewer. This gave so much better results than anything we had previously tried that we continued its use, and up to the present time have found nothing that is more satisfactory, considering the ease of manipulation, cost, etc. The method of making a joint with this material is similar to that used for lead joints, except that the material does not have to be calked. It also required very little heat to bring the compound to the proper consistency, a small wood fire being all that is necessary. We take the precaution to fill the angle between the bell and the barrel of the adjacent pipe with cement mortar, but do not think this is absolutely necessary, especially in the smaller sizes of pipe.

We have recently inspected some of the first work done with this material and have found the joints in perfect condition, and could see no change in the consistency of the compound itself.

[4]**Experiences at Cambridge, Mass., with Cement Joints.**—Our practice in making up the joints 8, 10, 12 and 15-in. pipes is to use Portland cement mortar and use the fingers and trowel in filling the joint and forming the collar outside.

Personally, I believe that the cement joint is likely to give as good results as any. Its simplicity, ease of handling the material and detecting imperfections, and its common use by masons and other workmen, are strong points in its favor. I believe, however, that the poured grout is the best way in which to use it and get a full joint. With the poured joint, liability of having an imperfect joint on the bottom side of the pipe is reduced to a minimum and must be the result of gross carelessness, as the bottom part should be best part of the joint by this method. The pipes are first lined up and centered, and a strand of oakum lightly driven into the joint, and then the joint is poured. Various devices have been suggested for holding the cement grout in place when poured. A very simple and inexpensive one is a sort of band or collar made of paper fabric about 2½ in. wide, one edge of which is attached to the bell of one pipe and the other edge is attached to the body of the next pipe, by cords passing around the pipe and firmly binding the collar to it. The grout is then poured into the joint space through a hole in the collar until it is entirely full. The collar can be left in place, as the expense of the collar is very small.

**Experiences at Waltham, Mass., with Sulphur Sand and Asphaltic Joints.**—For wet work both the sulphur-sand and the asphaltic compound joint have been thoroughly tried. The asphaltic joint has been adopted.

The first sulphur-sand joints were used in 1907, in a connection where a water and drain pipe were laid in the same trench. The water pipe was laid after the sewer, and, as a result of the jarring the sewer received, several pipes were broken, all of them on the line back of the bell. This joint was, however, used in several wet trenches later in that season. There is no difficulty in securing a sand in Waltham fine enough for the sulphur joint, and the men soon learned to heat the mixture properly. After that year, however, it was abandoned. The experience cited indicated that the joint was too rigid. The writer has never yet seen a sewer where there was not some movement of the pipes after they were laid. It might be only very slight and, with care, it need be only very slight, but in the case mentioned, where there was no appreciable change and the pipe was subjected to very little stress, failure resulted. Further experience goes to show that the decision to abandon the use of the sulphur-sand joint was a sound one. In 1917 a 300-ft. line of 5-in. pipe, laid 10 years before, where the joints were of the type now under consideration, was taken up and relaid at a lower level. When excavated, this sewer to all appearances was at a true grade and perfectly sound, but when jarred out of line, over a third of the pipes were found to be completely fractured at the back of the bell. The annular cracks were so fine that they could not be seen until the sewer was moved.

The asphaltic compositions since 1907 have been invariably used in wet places. Thus far no failures have been discovered. The Warren Bros.' pipe jointing compound has usually been employed. A jute gasket is calked into place and the compound poured into the joint in the usual manner. In shallow trenches every third joint, and in deep trenches every other joint, is made up in the trench; the rest are poured on the bank. With the asphaltic, as well as with the sulphur-sand, joints only deep and wide socket pipe was used. Both the inside of the bell and the end of the spigot should be scored by the manufacturer, else the pipes are liable to pull apart. Care must be taken to see that the compound does not break through the gasket and protrude into the sewer.

The asphaltic joint has been used in Waltham on domestic sewers only, and the danger of hot water melting the compound has never arisen. Its great advantage is that it has considerable flexibility and can be used in a wet trench and without an underdrain, unless there is more ground water than can be taken care of with a trench pump operated with a gasoline engine. A covering of Portland cement has sometimes been added to keep the compound in place, in case it should later be subjected to unusual heat; but, if the cement is to be made at all effective, this necessitates the introduction of expensive unwatering operations, which are not required with the composition alone. The cement covering was, therefore, used on the earlier jobs only.

A few years ago the department laid about 120 ft. of 10-in. pipe in a shallow, wet trench alongside of a brook. The ends were plugged and the sewer was

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[3] From the discussion of Henry A. Varney, Town Engineer, Brookline, Mass.

[4] From the discussion of L. M. Hastings, City Engineer, Cambridge, Mass.

[illegible]

left over night without back-filling. During the night the water rose considerably, and in the morning the whole 120 ft. of sewer was afloat. This experience increased our faith in the asphaltic jointing compound. When trying it out at the sewer yard, 4 years ago, two pipes joined together at that time were left there for observation. They have been exposed to all kinds of weather, kicked about and pretty well abused. The joint in these pipes is perfect today, and they are in as good alignment as they were the day it was poured.

[6]**Experiences at Fitchburg, Mass., with Cement and G-K Compound Joints.**—During the last 7 years in Fitchburg sewer pipe joints in sanitary sewers have been of two kinds, depending largely upon the trench conditions. Where the trench was comparatively dry with no probability that the water plane would for any length of time, if ever, be above the pipe, a cement joint was used. These joints consisted of a ring of jute calked in to assure a uniform annular space. The jute was soaked in a thin mixture of cement and water. The balance of the joint was filled with a 1-to-1 mixture of cement and sand pressed in by the hand and trowel and the outside smoothed off on a bevel. Portland cement was always used, and care taken to assure as tight a joint as possible, not on account of ground water but to avoid trouble from roots.

Where the water plane was normally above the pipe, and where there was water in the trench, a poured joint of what is commercially known as G-K compound was used almost wholly. Other similar material was used to some extent, but G-K seemed to be more satisfactory. A round commercial gasket was used. The joint was first calked with dry jute, using no more than enough to assure a uniform annular space and to prevent the jointing material from running into the pipe. Joints were poured when the water stood as high as 6 to 8 in. above the invert, and no difficulty was found in making the joints tight enough to prevent any objectionable leakage. The G-K was melted in a gasoline kettle owing to the better control of the heat than when wood is used. It was found advisable to keep the same workman on the kettle as there was less liability of injury to the material when a man has had some practical experience.

All sewer pipe used in recent years has been in 3-ft. lengths when obtainable, and also has had deep and wide sockets. Standard pipe is more economical than deep and wide socket pipe, as it takes less material to fill the joint. But with allowable variation in the diameter of the pipe the annular space with standard pipe was so small that it was decided to use deep and wide socket. It was considered that the cost of the additional amount of jute and compound or cement was more than offset by the better joint secured.

In the construction of drains or storm sewers, cement joints only were used, as with these sewers it was not expected that there would be any trouble from roots, and the elimination of all ground-water leakage was not considered important.

**Concrete Reservoir Floor Finished by Rolling.**—The concrete floor of new Waban Hill reservoir of Newton, Mass., was finished by use of a roller made of 3-in. pipe, the method of rolling being similar to that on concrete roads.

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[6] From the discussion of David A. Hartwell, formerly Chief Engineer, Sewage Disposal Commission, Fitchburg, Mass.

## Personals

Frank J. Noll, Jr., has been appointed manager of the garbage reduction plant of Indianapolis, Ind.

J. D. Kervin has resigned as city engineer and street commissioner of Waxahachie, Tex., and has accepted the management of a graphite mine at Llano.

James P. Murray, for the last 5 years civil engineer of the State Reclamation Department of Texas, has been appointed captain in the engineer section of the reserve corps of the army.

George T. Prince has resigned as engineer of the Metropolitan Water District of Omaha, Neb., to take a Government position in connection with housing and transportation of war industry plants.

Charles E. Ashburner, for the past 4½ years city manager of Springfield, O., is reported to have been appointed to a similar position at Norfolk, Va., at a salary of $9,000 a year, an increase of $3,000 over that paid at Springfield.

A. D. Bennett, for the past 3 years superintendent of the Arkansas Water Co. of Little Rock, Ark., has resigned on account of ill health. S. R. Brough, for 7 years manager of the water works at Marinette, Wis., succeeds Mr. Bennett.

E. J. Burkham, vice president of the Moreno-Burkham Construction Co., municipal contractors, St. Louis, Mo., has been appointed expert in charge of the commodity section of building materials in the Bureau of Supplies and Accounts, in Washington

E. W. Sayles, city engineer of Watertown, Wis., has been appointed engineer by the Department of Labor to have charge of Government munition housing plans in that city. Associated with Mr. Sayles will be the firm of Davis, McGrath & Kiessling of New York, and E. Vitale, also of New York, architects. The latter will be the "community planner."

The United States Fuel Administration has selected Henderson W. Knott to manage the field force of engineers and inspectors which is at work among the power plants of the country, carrying out a campaign of instruction and inspection designed to bring the use of fuel for the production of power to the highest possible efficiency and economy. Mr. Knott has been the general manager of the Morgan Crucible Company of New York City.

P. B. Findley, technical editor in the Department of Publicity, Westinghouse Electric & Mfg. Co., has resigned from that position to enter the Training School at the University of Pittsburgh, where he will take a special course in radio work, with the Signal Corps. Before going to the Westinghouse Electric Co. Mr. Findley was editor of the Electrical Age, in which position he made a large number of friends in the electrical field, who will wish him success in his military work.

Chester G. Wigley has resigned as chief of the Bureau of Engineering of the New Jersey State Department of Health to become affiliated with the engineering staff of Wallace & Tiernan Co., Inc., New York City. Mr. Wigley after graduating from Cornell University performed various engineering work connected with the construction of water purification plants and sewage disposal works, and in 1910 became associated with the engineering department of the New Jersey State Board of Health, being chief of the department for the last three years.

General C. C Williams, acting chief of ordnance, has appointed the following officers on a board to represent the Ordnance Department in the preparation and approval of plans for the construction of the Neville Island plant for heavy cannon and projectiles to be constructed by the United States Steel Corporation under the terms of the existing contract between the corporation and the Ordnance Department. The board will co-operate with the corporation in the planning, construction and operation of the plant: Colonel Chas. C. Jamieson, Ordnance, N. A., president; Colonel Chas. M. Wasson, Ordnance, N. A.; Lieutenant Colonel H. B. Hunt, Ordnance, N. A.; Lieutenant Colonel W. P. Barba, Ordnance, N. A.; Lieutenant Colonel F. E. Walters, Ordnance, N. A.; Lieutenant Colonel R. P. Lamont, Ordnance, N. A.; Major Chas. A. Walker, Jr., Ordnance, N. A.

## Obituaries

Daniel C. Corbin, multimillionaire railroad builder, died June 29 at Spokane. He was 83 years old. He constructed the Spokane Falls & Northern railroad from Spokane to Nelson, B. C., and the Spokane International railroad from Spokane to Kingsgate, Canada.

William R. Hill, consulting engineer, died June 13 at his home in Albany, N. Y., aged 64 years. In 1889 Mr. Hill was appointed chief engineer of the Syracuse, N. Y., water board, and in 1894 he was appointed superintendent. He had charge of the construction of the first conduit line from Skaneateles Lake to the city and of the Woodland reservoir from its inception to its completion.

## Industrial Notes

W. H. Callan, general manager plants, and W. P. Pressinger, general manager sales, have been elected vice presidents of the Chicago Pneumatic Tool Co., Chicago.

Robert F. Atkins, Eastern credit manager, Universal Portland Cement Co., has resigned to become credit manager of the Emergency Fleet Corporation. E. M. Johnson, formerly assistant credit manager of the Universal Co. at Chicago, succeeds Mr. Atkins at Pittsburgh, and A. J. Joyce of the Chicago office succeeds Mr. Johnson.

The Chicago Pneumatic Tool Co. announces the appointment of L. C. Sprague as its special representative in connection with the sale of pneumatic tools to railroads. Mr. Sprague was formerly connected with the Tool company, but more recently has been connected with the Railroad Department of The H. W. Johns-Manville Co., New York City.

The Westinghouse Electric & Mfg. Co. announces a change in representation in its Western District, with headquarters at Indianapolis, Ind. Prescott C. Ritchie has been appointed district representative to succeed H. S. Johnson, whose resignation became effective June 30. Mr. Ritchie has had a considerable amount of experience in the automobile industry, having been in charge of headquarters' inquiry work, for the Western District, in the main offices of the company for some years past, and prior to that time he was connected with the Thomas B. Jeffrey Co. at Kenosha, Wis.

*Railways and Government Works*
*Monthly Issue*

**ENGINEERING *AND* CONTRACTING**

Halbert P. Gillette, *President and Editor.* Lewis S. [illegible], *Vice President and General Manager*

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**Roads and Streets—1st Wednesday**
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies

**Waterworks and Hydraulics—2nd Wednesday**
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power

**Railways and Govt. Works—3rd Wednesday**
(a) Excavation and Dredging (c) [illegible]
(b) Rivers and Canals (d) Railway Construction

**Buildings and Structures—4th Wednesday**
(a) Buildings (c) [illegible]
(b) Bridges (d) [illegible]

Volume L. CHICAGO, ILL., JULY 17, 1918 Number [illegible]

# The Directors of the American Society of Civil Engineers Pass a Momentous Resolution

The American Society of Civil Engineers has frequently been accused of ultra-conservatism, and perhaps with some justice. But conservatism is a characteristic of all long established large organizations. Conservatism is, in fact, a mark of maturity. It may lead to inaction when there should be action, but young men are prone to forget that delayed action often prevents disastrous action. Conservatism is a source of strength as well as of weakness. On the whole the conservatism of the American Society of Civil Engineers has been for the good of the society and of civil engineers in general. Moreover, when this great society finally does take an important, and to it a novel, step, its reputation for conservatism then serves to arouse the keenest and widest interest in that step.

On June 18 this society, through its Board of Directors, passed a resolution that marks, we believe, the beginning of a new era in its existence. We quote:

> The development and application of the sciences in recent decades have caused profound changes in the social and industrial relationships of all peoples.
>
> The engineer has been a leader in this progress.
>
> Sociological and economic conditions are in a state of flux and are leading to new alignments of the elements of society.
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> These new conditions are affecting deeply the profession of engineering [illegible] to communities and nations, and in its internal organization.
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> A broad survey of [illegible] American Society of Civil Engineers is needed in order that an intelligent and effective readjustment may be accomplished so that the society may take its proper place in the larger sphere of influence and usefulness now opening to the profession.
>
> Such a survey and readjustment [illegible] successfully only with the aid of the membership throughout the country.
>
> [illegible] revision of the constitution of the society, which has not been materially modified for many years, during which the society has grown rapidly and has established 22 local associations of members.
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> [illegible] views of the membership of the society as to what its purposes and activities should be and as to the instrumentalities through which these purposes and activities should be carried out.
>
> Any changes in organization must take into account all the conditions above indicated, and also the relationship of the American Society of Civil Engineers to other engineering organizations and to the public.
>
> Therefore, resolved, that a committee be created to report on the purposes, field of work, scope of activity and usefulness, organization, and methods of work of the American Society of Civil Engineers, and to make recommendations concerning these matters; the committee to consist of one member chosen by each local association of members, and seven members at large appointed by the president.
>
> Resolved, That the president be instructed to select from this committee an executive committee of not less than five nor more than nine members and to appoint the chairman of this executive committee, who shall also be the chairman of the general committee.
>
> Resolved, That the president be instructed to prepare a precept for the general guidance of this committee.
>
> Resolved, That this committee be requested to present to the Board of Direction a preliminary report, not later than Nov. 1, 1918, so that it may be printed and distributed to the membership in advance of the annual meeting in January, 1919, at [illegible]

This resolution makes it clear that a majority of the Board of Directors of the society has reached the conclusion that the time has come for the society to become a greater factor in social and industrial affairs. "The engineer has been a leader" in social and industrial progress, but he has been a leader by virtue of individual ability rather than because of organized action on the part of engineers.

Until very recently all engineering societies have held aloof from what is called "political affairs," and very few engineering societies have given much consideration to industrial matters—scientific management and the like. Individual engineers, here and there, by sheer force of their own determination and skill, have made themselves managers of cities, of industrial plants, of mines, and, more recently, of war activities. Finally these engineers, realizing their weakness when acting alone, began to call for organized aid from their brother engineers; and they have not called in vain. First, local engineering societies and clubs began taking part in local politics. This was followed by similar action by national societies now and again. Then the Engineering Council came into existence, and made it part of its program to guide public action. Finally, we have come to what promises to be the most momentous step of all—the entrance of the oldest national engineering society into the arena as an active champion of the engineer as an industrial and social leader.

Sixteen years ago the chief editor of Engineering and Contracting, then one of the editors of Engineering News, began writing a series of editorials urging engineers to enter the field of industrial and political management. Upon taking charge of the editing of Engineering and Contracting in 1906, he continued this series of editorials, and broadened its scope. For a long time no other editor joined in this campaign to induce engineers to become managers and leaders, and not to remain merely technical designers. But the soundness of this editorial policy finally began to arrest the attention of other editors of engineering periodicals and ultimately led to its unanimous support. Yet, so slowly do long established opinions change that 16 years have elapsed before the first great national society of engineers has taken the initial step toward organized support of the engineer as industrial and social manager and leader.

The editor trusts that his readers will pardon an expression of his personal elation at the fruit that has sprung from an editorial seed planted 16 years ago and sedulously cultivated through all those years. Doubtless some other editor would have planted the same seed ultimately, for it was the destiny of the engineer to apply science, not only to design but to management. It was the editor's good fortune to have been among the first to see the first flush of the dawn of a new era, and to call upon others not only to look at the rising sun but to plant and cultivate the soil on which it was about to shine.

## Should Government Clerks Have a Shorter Day than Other Clerks?

Government clerks have long enjoyed a 7-hour day, or an hour shorter than is common for similar employes of companies and individuals. Congress recently passed a bill in which it was provided that Government clerks should work 8 hours. The president vetoed the bill on the ground that he had already declared his policy to be that the conditions of labor should in no respect be altered unfavorably to the laborers because of war requirements.

The president's veto of this bill may have been right, but his reason for it will scarcely bear examination. It is one thing to declare against requiring skilled mechanics and laborers to work 9 or 10 hours, instead of 8, because of labor shortage. It is quite another thing to oppose a law requiring Government clerks to work as many hours as clerks work for almost all other employers except the Government. There never has been a sound economic reason why Government clerks should be a favored class, and Congress had finally decided to rectify the inequity. The president ignores this inequity in writing his veto, and appeals to a policy that was founded on principles both of equity and of economics; for the 8-hour day is not only economic but has become so widely established that it should be made universal in America in order to secure equity. The president's veto, in fact, is directly contrary to the very policy that he cites in its support, for it serves to maintain a condition of inequality—a 7-hour day for Government clerks when the general practice has established an 8-hour day.

Those who favor Government ownership of public utilities will do well to remember such facts as this. The tendency in a country where votes largely determine public policies is to give the voters what they want regardless of equity or economics.

## Chinese Poverty Largely Due to Lack of Roads and Railways

Before China can enjoy a prosperity worthy of the name, a great mileage of roads and railways must be built. A good road can be built in China for about $5,000 a mile. A narrow gage (24-in.) railway costs about $8,000 a mile, and has a very limited capacity compared with a road. Only a few of the Chinese railways are standard gage, but engineers familiar with Chinese conditions state that narrow gage railways are no more to be desired in China than in America, as an economic transportation plant.

With good roads and motor truck transportation, feeder railway lines can be dispensed with; and, for some years to come, only main line railways need be built in China.

Skilled Chinese mechanics earn 25 ct. a day, while the wage of a common laborer is 15 ct. These low wages are obviously due to the inefficiency of the average workman. The inefficiency is not the result either of lack of physical power or of brains, but comes mainly from the lack of labor saving plants and tools and from the ignorance of managers.

Nearly all roads in China are mere footpaths over which man-pulled wheelbarrows, donkeys and mules carry the loads. A Chinese wheelbarrow carries 250 to 800 lb., depending on road conditions; and since the wage of a wheelbarrow coolie is only 14 or 15 ct. a day, the cost of haulage is 4 to 12 ct. per ton-mile. A mule carries 180 to 250 lb., and the cost of transportation by mule averages about 6 ct. per ton-mile. It is estimated that the present cost to the Government for freight haulage by rail averages about 0.5 ct. per ton-mile, and that haulage over good roads with motor trucks would not much exceed this cost.

With the present primitive methods of transportation it is evident that a very large part of the population must be engaged in moving produce from place to place. Perhaps half the workers in China are busy wheeling and carrying things about. In America only 7 per cent of our 38,000,000 workers are employed directly in transportation, and of these about half are steam railway employes. If we include those who are indirectly engaged in transportation, that is in mining coal and metals and in manufacturing plants for transportation purposes, about 10 per cent of all our workers are occupied in transportation. To this should be added the time of farmers spent in hauling crops, etc., to and from shipping places. If we estimate that the farmer spends one-sixth of his time in such hauling, then less than 2 per cent is to be added to the 10 per cent, making a total of 12 per cent of our total working time spent directly and indirectly in hauling produce and passengers on steam and electric railways and in horse-drawn wagons, motor trucks and delivery autos.

If by the building of roads and railways China could release, say, 35 per cent of its entire working population from present transportation services, and divert them to manufacturing, mining and agriculture, Chinese poverty would cease to exist.

A great social problem confronts the Chinese, and they seem to be about to undertake its solution. Once they begin intelligently to rescue themselves from penury, American engineers, manufacturers and financiers should be able to assist them beyond measure.

## How to Determine Whether a Crushed Stone Stock Pile Pays

In the production of crushed stone throughout the year it is usually profitable to provide a stock pile, in spite of the extra cost of rehandling the stone. The main reason for this is that a smaller quarrying and crushing plant working continuously will produce the desired annual output at less cost per ton, inclusive of stock pile costs, than the cost per ton incurred by a larger plant, without a stock pile, working below full capacity most of the time.

Electrical engineers use the term "load factor" to denote the ratio of the actual annual output of electricity to the possible full capacity output of a plant. Thus, an electric generator of 1,000 kilowatts capacity is capable of generating 8,760,000 kilowatt hours of current in a year of 8,760 hrs. (i. e., 24 hrs. daily for 365 days). If, then, such a generator is so run as to generate 2,190,000 kw. hrs. in a year, its load factor is 25 per cent.

Since all the annual "fixed charges" on a generating plant are independent of the output, it follows that if the load factor can be doubled, the fixed charges per kilowatt hour will be cut in two. In general, then, the cost of the "fixed charges" per unit of output vary inversely with the load factor. This holds true of all plants, and serves to explain the economy of providing a stock pile for a crushed stone plant that can be operated the year around at a uniform weekly output.

Stone can usually be delivered to and loaded from a stock pile at a cost of 5 to 10 ct. per ton, depending on the scale of operations and the kind of plant used for stock piling and rehandling. Assuming the first cost of a quarrying and crushing plant to be $80 per ton of daily capacity, and that interest, depreciation and taxes are 20 per cent annually, we have 5.3 ct. per ton for fixed charges on a plant when run continuously one shift every day for 300 days. But without a stock pile continuous operation is usually impossible. To meet the "peak demand" for stone the plant must usually be fully twice the capacity required under continuous (one-shift daily) operation. This alone adds 5.3 ct. per ton of stone for fixed charges on the plant, or enough to cover the cost of stock piling and rehandling under ordinary conditions. But this is not the only element of cost affected by the "load factor" or output factor. A plant large enough to take care of peak demands for stone must necessarily have a crew of men capable of running it at its capacity, and most of this crew must be kept on the pay roll when the plant is operating at but a fraction of its capacity. Some of the crew must be paid even when it is not operating at all. So that either failure to secure freight cars regularly or a falling off in immediate demand for the stone results in the paying of full wages to most of the crew, regardless of the low output of the plant.

In the solution of a problem of this character the first step is to estimate the total annual tonnage of stone to be delivered. The next step is to estimate the maximum delivery that will be required for any single day, also for any single week, and for any single month. Then estimate the first cost of a plant that will supply the maximum daily output aided by the storage capacity of the bins, but unaided by a stock pile. Estimate the operating expenses, interest and depreciation charges for such a plant for a year, under the fluctuating daily, weekly and monthly outputs. Divide this total cost by the total annual tonnage and ascertain the cost per ton. Compare this unit cost with the unit cost resulting from operating a smaller plant continuously with the aid of a stock pile, including therein the interest on the average amount of money tied up in the stone in the stock pile. If the smaller plant with the stock pile shows a lower cost per ton (as it usually will) than the larger plant without a stock pile, then it is obvious that the smaller plant is more economic.

## The Engineering Council Opposes a Bill to Abolish Bonus Payments

The Engineering Council has already shown its ability to act promptly and intelligently in opposition to ill-advised laws. When Congress was about to pass a bill prohibiting the payment of rewards or bonuses for efficient performance, the following resolution was sent by the Engineering Council to each member of the Senate committee on naval and military affairs:

> Whereas, [illegible] industry, and,
>
> Whereas, We are informed that Congress has under consideration in the Naval and Army appropriation bills proposals to prohibit, diminish and condemn the payment to public employes or to employes of private establishments under Government control any cash reward, premium or bonus for superior service, and,
>
> Whereas, These methods if applied with due regard to wages surroundings, health and safety of the employes, will increase efficiency and production, help win the war and preserve our institutions; be it, therefore,
>
> Resolved, That in the opinion of Engineering Council, representing American Society of Civil Engineers, American Institute [illegible] and American Institute of Electrical Engineers, together having 33,000 members, it is vital to the winning of the war that no legislation or other measure should be adopted which may interfere [illegible] on the contrary every proper means should be taken to increase efficiency and production.

Coming from the representative of 33,000 engineers, such an indorsement of the bonus system of payment is very impressive, and should have its effect upon Congress. It is to be hoped, however, that the Engineering Council will not let the matter rest with the sending of this resolution, but will send a committee to Washington to see the military and naval committees of both houses of Congress, and the president also. No slight amount of educational work will be necessary to convince Congress that the labor unions are wrong in their contention that piece-rate and bonus payments result in a speeding up of work that is injurious to the health of the workmen. Labor unions have almost always opposed any system of payment that puts a premium on efficiency, and have contended for a uniform wage for similar occupations regardless of efficiency.

A few labor unions, notably among coal miners, have been won over to piece-rate systems of payment; and all unions will ultimately be convinced that an application of the fundamental law of scientific management, namely "payment in proportion to performance," will be even more beneficial to the employe than to the employer. The great majority of engineers have no ax to grind in contending for the universal application of this economic law. Hence both Congress and the labor leaders will be particularly impressed by the contention of the Engineering Council that bonus payments "will increase efficiency and production, help win the war and preserve our institutions."

## The "Employment Manager" Becomes the Soul of the "Soulless Corporation"

The selection, training and treatment of employes is a managerial function that has become progressively more important, and the war has served to emphasize its importance. All the large companies have employment managers who specialize in the problems of securing, educating and keeping employes that have been educated. Thus a new profession, that of employment manager, has evolved. A National Association of Employment Managers was organized in May, and members of that association witnessed the graduation of 24 young men who had finished a course in employment management at the University of Rochester, Rochester, N. Y.

These graduates are the scientifically trained pioneers of this new profession. It will be their function not only to select and train men and women for industrial occupations, but to be themselves the souls of hitherto "soulless corporations." To them will fall the duty and the pleasure of improving living conditions for employes, of guiding them toward more wholesome and healthier habits, of inspiring in them hope of a progressively better mode of living, and, finally, of showing them how better ideals may be realized.

The paternal relationship of the clan leader to the clan was destroyed when the factory system displaced the feudal system, and this was a great loss to humanity. Are we not about to see a revival of the ancient system of paternal leadership, wherein the superior wisdom of the employer is not devoted solely to his own personal betterment but largely to the betterment of his employes? We think so. Paternal and fraternal feelings have been so deeply aroused by war conditions that we may reasonably hope to see these altruistic feelings remain in full force after the war ends.

Employment managers of the right type—the type of blended science and sympathy—have it within their power to make employes loyally enthusiastic because they feel that they are regarded less as machines than as men, less as clods to be harrowed for profit than as souls capable of endless progress.

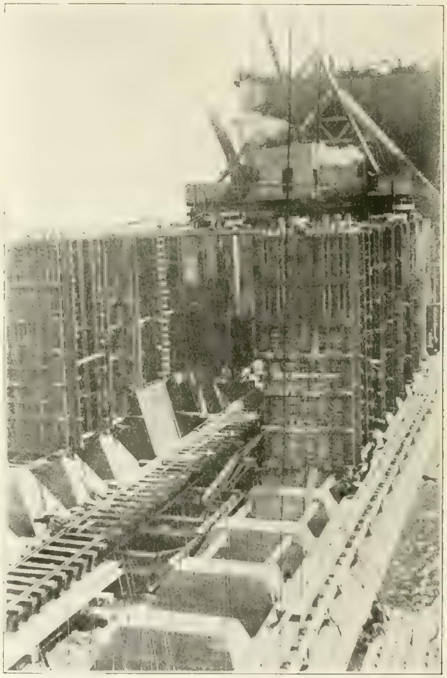
**Breaking Up Frozen Ground for Steam Shovel Work.**—A 14 to 18-in. frost crust encountered in winter steam shovel work was effectively broken up by boring horizontal holes at the frost line and blasting with low freezing farm powder. The holes were spaced on 3½-ft. centers and each hole loaded with ¾ lb. of Du Pont farm powder. The firing was done by electric battery. The charge broke up the frozen ground so that it could be handled in chunks by the steam shovel.

## The 600 Ft. Reinforced Concrete Extension of N. P. Ry. Ore Dock at Superior, Wis.

By W. D. ENGELKE.

Construction was completed June 1, 1918, on a 600-ft. reinforced concrete extension to the Northern Pacific Ry. Co.'s ore dock at Superior, Wis. The addition was authorized late in 1916 and was commenced in December of that year. The extremely late spring and scarcity of labor in 1917, however, somewhat delayed the progress of the improvement.

**Old Pockets of Structural Steel, New Ones of Reinforced Concrete.**—The old dock was built in 1913-14 and was 612 ft. long. It contained 102 pockets, 51 on each side, holding 350 tons of ore, making a total of 35,700 tons for the unit. The second unit just completed has 100 pockets, 50 on each side, each holding about 400 tons of ore, making a total of 40,000 tons for the unit. The old or first unit pockets were built of structural steel. The beams forming the walls and floors were filled with concrete and a 4-in. hard maple floor laid on this. The bin fronts were curved sheet steel.

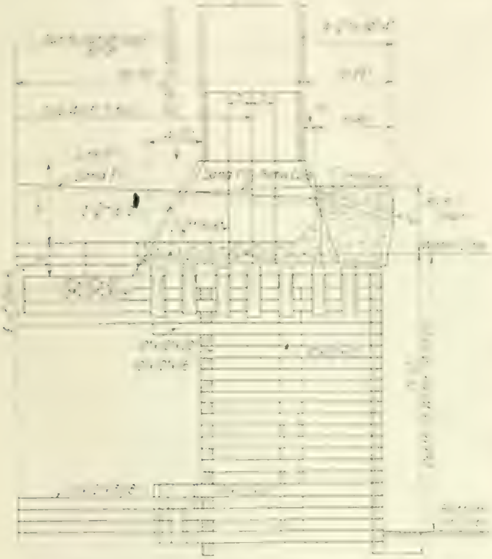


Forms for Bottom and Outside Walls of Pockets. Conveyor Belt on Fender Shown at Lower Right.

The new pockets are built entirely of reinforced concrete. The floors are of slab construction 12 in. thick at the top or center line of dock and 18 in. thick at the bottom or outside of dock.

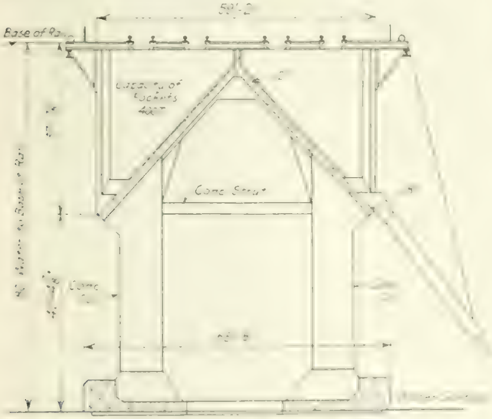
The bin walls between pockets are 16 in. thick and the front walls on outside are 10 in. thick. The dock is built in sections of 10 double pockets each, making each section 120 ft. long, separated by extension joints extending through the entire structure.

**Door and Chute Equipment.**—Both units of the dock are equipped with the "Dickinson" doors. The new doors are 7 ft. wide and for this reason the trouble caused by clogging ore is expected to be overcome. The doors are opened and closed by a drum and cable device located on top of the dock, making it unnecessary for any one to be at the doors except when "punching" ore. A test was made of one of the new pockets and 8 cars, about 320 gross tons, were emptied into a boat in 1 minute.



Typical Half Transverse Section of Foundation.

The chutes or spouts are of sufficient length and movement to enable the largest or smallest boat to load when alongside and to permit placing the ore in any part of the hold.



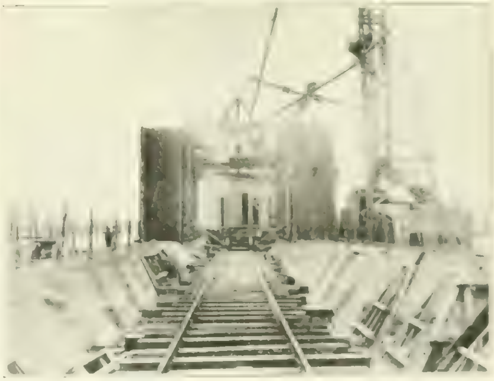
Typical Cross Section of Ore Bin

## Method of Constructing Ore Dock Extension.

**Timber Crib Built on Ice.**—A trench 70 ft. wide was dredged out to a depth of 25 ft. Then a crib built of 12-in. x 12-in. fir timbers laid on top of each other and drifted bolted together and tied across was started on the ice. When built up 6 ft. it was cut through the ice and additional courses added until a depth of 25 ft. was reached. In order to sink the crib sand pockets were constructed on either side 72 ft. apart, and sand was hauled out on the ice by team and shoveled in by hand. After the crib was sunk into place two swing lead pile drivers were used to drive the 3,600 white and Norway pine piles of from 54 to 60 ft. in length.

**Method of Cutting Holes Through Ice for Piling.**—As the ice around the dock site was about 5 ft. thick it was quite a problem to get holes cut through. To accomplish this a 1-in. gas pipe was bent to form a circle 18 in. in diameter with a stem 6 ft. long extending up, to which a 1-in. steam hose was attached. The bottom of the circle was perforated with $\frac{1}{8}$-in. holes 3 in. apart. With this apparatus it was possible to thaw a hole 20 in. in diameter through 5 ft. of ice in from 4 to 5 minutes. A pair of ice tongs were used to lift out the "core" and permit the pile to go through.

**Circular Saw Used to Cut Off Piles Below Water Line.**—In driving the piling, the sand pocket spaces were skipped until after all the other piles were driven and the crib filled to within about 10 ft. of the top with sand. Then the piles were driven through the bottom of the sand pockets. After all the piling was driven the crib was filled level full of sand, and the piles were cut off 1 ft. below the water line, even with the top of the crib. To do this, The Whitney Bros. Co. of Superior, Wis., used a large circular saw, 48 in. in diameter, $\frac{1}{2}$ in. thick, mounted on a large scow and driven by a steam engine. With this arrangement as many as 500 piles were sawed off in 10 hours.



Pedestal and Column Construction and Form. Concrete Plant on Right

**Fenders and Concrete Mattress Foundation.**—The outside fender forms were then set in place on the outside crib wall and the 3-ft. concrete mattress foundation was placed, care being taken to prevent washing when placing concrete in water. After the mattress was poured the pedestals and balance of fender was poured, after which the columns and pockets were poured. Two complete double pockets were poured at each run, the total concrete amounting to about 350 cu. yd. Construction joints were made through center of pocket, by bulkheads.

The steel "I" beams were then placed on bearing plates on top of the bin walls and held in place by anchor bolts. Then the bin mouths, chutes, hoists, motors, handrails, walks, etc., were placed.

**Forms Handled by Derricks and Locomotive Crane.**—The fender forms were handled with a derrick scow. The pedestal and column forms were handled with a Brownhoist locomotive crane run on a temporary track constructed in the center of the dock by placing timber bents on the mattress and using the new steel "I" beams for stringers.

The lower or under forms of the pockets and outside wall forms were handled with a stiff leg derrick, 80-ft. boom, mounted on a track on top of the columns. The inside pocket forms were handled with a stiff leg derrick, 80-ft. boom, mounted on a track on top of the bin walls.

**Handling Sand and Gravel for Concrete.**—The sand and gravel were delivered in hopper bottom or ballast cars on a track constructed under the old part of the dock. A hoisting engine was used to draw the loaded cars up an incline to the top of the gravel bins. The sand or gravel as needed was delivered through openings in the bottom of the bins onto a 16-in. conveyor belt running the entire length under the gravel bins. This delivered the material onto a transverse belt conveyor and this in turn delivered onto a belt conveyor running the entire length of the dock on the fender. This conveyor then delivered the material onto a link belt bucket conveyor which placed it in bins constructed over the concrete mixer. A movable trip made it possible to spot the scow containing the concrete plant at the most convenient location.

**Concrete Plant.**—The concrete plant was mounted on a scow 32 ft. x 80 ft., which was rather small for storing sufficient material to work to the best advantage. The concrete plant consisted of a ¾-yd. Lakewood mixer and an Insley type tower 130 ft. high with a suspended bracket and boom which supported the concrete hopper and chute. With this arrangement the chute could be raised and lowered to the proper height for pouring foundation, columns or brackets. The following materials were used:

Timber in crib, 900,000 F.B.M. Washington fir; cement, 29,000 bbl.; reinforcing steel, 635 tons, ⅜-in. to 1⅛-in., all deformed bars; structural steel, 1,200 tons, furnished by the American Bridge Co. The motors and hoists were furnished by Clyde Iron Works of Duluth, Minn.

The dredging was done by the Zenith Dredge Co. of Duluth, with the "Alice Vivian" hydraulic dredge. The electrical work was done by the Northern Electric Co.

The contract was on a unit price basis, the railway company furnishing all material except the sand and gravel. This was supplied by the Zenith Concrete Gravel Co. of Carlton, Minn. The total cost of the extension was about $750,000.

The general contractor was the Simms, Helmers & Schaffner Co. of St. Paul. Mr. N. F. Helmers was in charge of the work for the contractor. Mr. P. W. Stickney, Assistant Engineer, represented the railway company.

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**$200,000,000 Proposed for Power Plant.**—William Potter, Pennsylvania State Fuel Administrator, has notified Dr. Harry A. Garfield, National Fuel Administrator, that special legislation for the appropriation of $100,000,000 to finance huge, new power plants is imperative if coal mining in Pennsylvania fields is to be kept up to the requirements. Already a bill appropriating $200,000,000 for increased power production is in preparation, and will be introduced soon into Congress.

# Methods and Cost of Stocking Bituminous Coal

An interesting experiment is being carried out at the University of Illinois, Urbana, Ill., in the stocking of Illinois coal. The methods employed in the work are described in a 192-page bulletin, "The Storage of Bituminous Coal," issued recently by the Engineering Experiment Station of the University. This Bulletin, prepared by H. H. Stock, Professor of Mining Engineering at the University, is a very complete review of modern practice governing the storage of coal.

The annual coal consumption of the University is about 30,000 tons, the daily minimum being 50 tons and the maximum 150 tons. For several years it has been customary to stock from 4,000 to 5,000 tons on the ground in piles about 12 ft. high. The coal is thrown by hand from railroad cars upon the pile, distributed by scrapers, and then hauled by wagons to the power house. At times fires have occurred in these piles.

At the present time an area 114 by 196 ft. is being used, and since this space was formerly used for tennis courts, the base is of firm, smooth clay. The storage space has on three sides a plank fence 7 ft. high, the posts being tied by wire rope to pegs within the enclosure. When the enclosure is filled to a depth of 15 ft. it contains about 10,000 tons. This storage plat is about 1,000 ft. from the power house where coal is received and in which is located the machinery for the necessary crushing and screening of the coal prior to storage. The coal is dumped from coal cars into a track hopper from which it is elevated. When intended for storage, the coal is diverted from the bunkers which feed the boilers. If the coal consists of screenings or the size of lump desired for storing, the railroad car dumps it into a pit from which it is elevated to a bin and then discharged into an end dumping motor truck. If lump coal or a size not desired for storing is received, it is crushed, if necessary, and screened; then by means of the storage truck which holds 3½ tons it is taken to the storage ground.

At the storage plant a truck running on the ground first builds up a bed of coal from 2 to 5 ft. thick from the fence toward the center. When this center becomes too small to provide space of handling the truck, the operation continues on top of the first layer already in place, and a second layer is similarly deposited, the bed thus being built layer upon layer. To permit the truck to work on top of the pile of coal a track is built of pieces of scrap plank, 2 by 3 ft., woven together with galvanized wire or cable. The cable is more flexible but more costly than the wire. This track is in sections, of from 5 to 8 ft., and two lines are laid on which the truck runs. A track of wire fencing has been tried, but it is not stiff enough to provide a satisfactory running base for the truck.

An effort is made in storing the coal to have it thoroughly packed and to exclude the air as much as possible. Regular temperature observations are taken with an iron rod. This method differs from the ordinary pile storage in the tamping of the fine coal to exclude the air.

A plank track for the truck is laid between the storage pile and the power house, and by rapid loading and fast driving a round trip is made in from 7 to 8 minutes; thus 19 tons are stored per hour. Three men are used on the pile for cleaning out the truck and spreading the coal. The coal is separated into two parts, screenings being placed on one side of the storage space and lump coal on another, but the two piles come together. The coal is reclaimed with an electrically operated Jeffrey wagon and truck loader.

The expenses of handling are given in the following statement:

EXPENSE OF HANDLING COAL AT UNIVERSITY OF [illegible] POWER PLANT

Expense of [illegible] bottom dump cars [illegible]:

| | |
|---|---|
| Labor | [illegible] |
| Team | [illegible] |

[illegible]

Expense of labor and team for [illegible] 500 ft. away, per ton.

| | |
|---|---|
| Labor | [illegible] |
| Team | [illegible] |
| Total | [illegible] |

Expense of labor and team for unloading screenings from bottom dump cars to hopper and for loading wagons from overhead bunker and hauling to storage [illegible] per ton.

| | |
|---|---|
| Labor | [illegible] |
| Team | [illegible] |
| Total | [illegible] |

[illegible] overhead bunker and will return 7½ tons per hour from storage [illegible].

EXPENSE OF STORING COAL WITH TRUCK

(Truck will handle 19 tons per hour.)

| | |
|---|---|
| Expense of [illegible] | [illegible] |
| Expense of trimming pile, building roads, etc. | 0.06 |
| Expense of [illegible] | [illegible] |
| Expense of [illegible] | [illegible] |
| Expense of unloading screenings from bottom of dump cars, elevating and unloading trucks | 0.07 |
| Total | [illegible] |

EXPENSE OF REMOVING COAL FROM STORAGE

| | |
|---|---|
| [illegible] | [illegible] |
| 1 [illegible] | 0.30 |
| 1 man leveling load at 30 ct. per hour | 0.30 |
| 1 [illegible] | [illegible] |
| 2 men at plant hopper at 30 ct. per hour | 0.60 |
| 2 [illegible] | 0.60 |
| Truck operation and maintenance | 0.60 |
| Total expenditure per hour | [illegible] |
| Expenditure per ton | [illegible] |

## Drilling Rig Mounted on Rollers

A special drill rig mounted on rollers has proved very efficient at the quarries of Evert P. Maule, at Ojus, Fla. The rig is built exactly like a pile driver, the steam drills sliding up and down in the leads in the same manner as a drop hammer. The drill is raised by means of a block and tackle using ½-in. rope on a drum, which a driller handles. The steam drill is bolted to a frame to give it extra weight. This frame has channels to fit the leads. The rig is moved quickly on its rollers from hole to hole and long bits are used, thus saving the time lost in changing bits. Mr. Maule states that with the rig he is able to do about twice the ordinary amount of drilling that could be done with the usual outfit.

**70 Per Cent of Levee Construction in Louisiana Done with Power Driven Machinery.**—Levee construction involving 23,413,268 cu. yd. of earth work was carried out in Louisiana during the two years ending April 20 last. Of this work 70 per cent was accomplished by power driven machinery, 24 per cent by mules and scrapers and 6 per cent by men with wheelbarrows. The unit costs by these methods, according to the last annual report of the Board of State Engineers were as follows:

| | |
|---|---|
| Power driven machinery | [illegible] |
| Mules and scrapers | [illegible] |
| Men with wheelbarrows | [illegible] |

The work included the building of 65.17 miles of new levee and the enlargement of 232.42 miles of old levee.

## Concrete Roadbed on Northern Pacific Ry.

An experimental concrete roadbed has been laid by the Northern Pacific Ry. on a new line between Tacoma and Tenio, Wash. The section was built in a gravel cut in the summer of 1914, and while sufficient time has not elapsed fully to test its ultimate economy, it is reported satisfactory as a whole. Some minor changes will be made when more concrete roadbed is built. The construction is described in a recent issue of Concrete, to which we are indebted for the matter in this article.

Figure 1 shows the construction. The slab is approximately 16 in. thick, reinforced both ways. It is placed in 33-ft. sections, separated by an interlocking expansion joint filled with mastic.

The attaching and cushioning of the ties is provided in an ingenious manner. Castings, made in three sections for removal, are suspended rigidly and in exact alignment by overhead form members. Each casting is held by two 1-in. bolts.

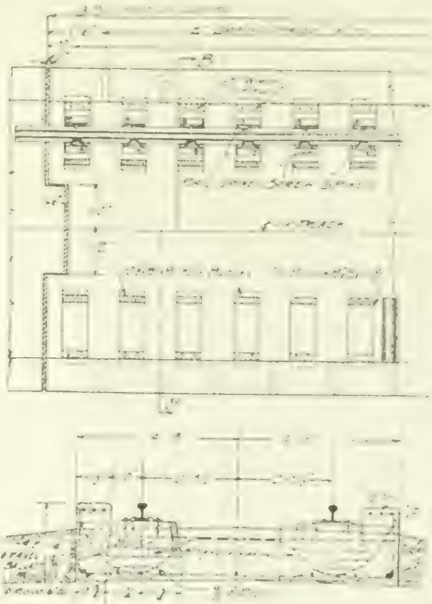


Fig. 1—Details of Concrete Roadbed Construction.

The forms were not essentially different from those used on street and curb work except for suspension members for holding and removing the cast iron core forms. When concrete has been placed the nuts on the bolts suspending the cores are run up 4 in., the supporting members raised and rebolted and the cores drawn steadily and in an exactly vertical plane by the screws.

Drainage is provided by 2-in. weep holes, 18-in. o. c., through the curbs. The rails are secured to 8-in. x 8-in. x 20-in. block cut to correspond to the holes. The blocks rest on a 3-in. sand cushion.

The blocks are set in place on the sand cushion; rails temporarily placed and a locomotive runs over them thoroughly to settle the blocks. The blocks are then finally aligned and keyed by driving 2-in. x 8-in.

blocks. Exact lateral adjustment is provided by shims. The specifications provide instruction as follows:

Concrete—All concrete to be 1:3:5 mixture, conforming to the requirements of the N. P. Ry. specifications for bridge substructures.

Reinforcing Rods—All reinforcing rods to be deformed high elastic limit bars conforming to the requirements of the N. P. Ry. specifications.

Construction—Dress sub-grade to the slope shown and set side forms and skeleton top forms to hold tie pocket core forms. Place and wire steel reinforcement. If sub-grade is gravelly, the entire surface inside the forms shall be thoroughly wet down immediately previous to pouring concrete, and the bottom layer of concrete shall be mixed with an excess of mortar. Concrete shall be mixed wet enough to fill out the forms and get good bond on the reinforcement, but care must be taken to avoid an excess of water which would interfere with finishing the top surface. The top surface of slab to be floated to a smooth, uniform slope to the drain holes. At alternate third points of slab space between three ties to be troweled out to clear an Abbott rail joint plate, and drain holes lowered to correspond.

Track Laying—Put in a layer of torpedo sand, approximately 3 in. thick, in each tie pocket, and level off to true grade.

Set in the 8 in. by 8 in. tie blocks, omitting lining shims and key blocks. Lay tie plates and rails, omitting all screw spikes. Run a heavy engine back and forth along the track until all blocks are thoroughly settled into place. If necessary, reline and resurface and repeat until track remains in true surface and alignment, then fit in key blocks, and if necessary to secure tight fit and bearing, put in lining casting and lining shims. Finish rail fastening by adding two screw spikes to each tie plate. Mastic to be composed of 1 part asphalt to 4 parts sand.

## Blasting Down Clay Bank

In the construction of a road near St. Marys, Md., it was necessary to move a bank of clay about 400 ft. long and 10 to 12 ft. high, with an almost perpendicular face. The clay was very hard and difficult to pick so it was decided to blast down the bank and move the dirt with scrapers. The work was handled as follows:

Five feet back from the edge or face, holes 5 ft. deep and 5 ft. apart were put down with an earth auger. A 6-hole test shot was fired to see if the spacings were right. Electric blastings caps were used. Four cartridges (2 lb.) of 30 per cent dynamite were loaded into each hole. The charges were tamped in tightly so as to get the full force of the shots, and were fired with a standard blasting machine.

In charging the holes the cartridge paper was slit so that the dynamite could be packed more closely into the bottom of the hole; that is, this was done with the first three cartridges loaded in the hole. The top cartridge containing the cap was not so treated. Loading in this way made it possible to get more tamping over the charges, thus confining them better and giving better execution.

After the shot it was found that the top of the bank had been blown off, but the ground had not been loosened up down to the desired depth. On the next shot the holes were slanted, making the bottom of the borehole nearer the face of the bank than the top. This reduced the burden of earth to be lifted and loosened.

The work was completed in ten-hole sections, as that was the capacity of the blasting machine. The work was finished in less than two days, using 200 lb. of dynamite and 82 electric blasting caps. The contractor estimated that the entire cost of the work was about one-third what it would have been had laborers been employed to pick the clay loose.

A $250,000 drainage job near Greenville, Miss., has been awarded at 12 ct. per cubic yard. Work calls for 70 miles of 12 to 20-ft. bottom ditches.

## The American Railway Commission and Russian Railroads

The American Railway Commission, appointed at the request of the Kerensky Provisional Government to advise with Russian railway officials, was the first Government board sent by this country to Russia after the revolution of March, 1917. The commission, consisting of John F. Stevens, chairman; Henry Miller, George Gibbs, W. L. Darling, and J. E. Greiner, all experienced railroad engineers, arrived in Vladivostok on May 31, 1917. The conditions found by the commission were described by Mr. Greiner in an address delivered recently before the Engineers' Club of Baltimore, from which the matter following is abstracted.

**General Facts of Russian Railroads.**—During the spring of 1917 the total mileage of all government and private railways in European and Asiatic Russia (exclusive of Finland) was approximately 43,300, of which amount about 75 per cent was single track and 25 per cent was double track. The Germans had taken possession of 4,000 miles and this left 39,300 miles still under the control of the Russian Government. In addition there was under construction and under consideration about 9,700 miles of new lines, parts of which were in temporary operation along the front. The total length of the railways examined by the commission as a body was 8,235 miles or about 21 per cent of all the lines under control of the Russian government at that time.

The so-called Trans-Siberian Ry., while a continuous line of tracks from Vladivostok to Petrograd and to Moscow, is not by any means a single railway as is usually supposed by Americans. The line to Petrograd is made up of six different railways under separate and distinct managements, subject only to a general control at Petrograd. There is a double track between Vladivostok and Nikolsk, a distance of 68 miles; then a single track between Nikolsk and Kataisky, a distance of 1,237 miles; then a double track (with the exception of a few bridges) between Kataisky and Omsk, a continuous stretch of 2,261 miles; between Omsk and Petrograd there is a continuous single track of 1,869 miles. This gives a total length of continuous line between Vladivostok and Petrograd of 5,435 miles.

The double track railway on the Trans-Siberian between Kataisky and Omsk, a continuous stretch of 2,261 miles, is the longest continuous double track line of railway in the world. The distance from Vladivostok to Petrograd, namely, 5,435 miles of continuous railroad, is about 1¾ times the distance from New York to San Francisco by the shortest route, and is about 1½ times the length of the Canadian Pacific from its eastern to its western terminal. If the new Amur Line be considered as a second track, which to all practical purposes it is, then the Trans-Siberian Ry. is a double track from Vladivostok to Omsk, a distance of about 3,566 miles, which is greater than the distance across the American continent.

**Condition of the Russian Railways.**—There were on the railways at the time of the inspection about 17,600 locomotives, or about 1 to 2.1 miles of road as against 1 to 4 miles in America; and the average age of all was about 24 years. On some parts of the Trans-Siberian, locomotives use wood for fuel, and on other parts coal, there being perhaps 15 per cent of the locomotives in service burning wood. The most numerous class of freight locomotives is a 4-axle engine weighing from 50 to 52 tons, and the heaviest engines in service are the American Decapods weighing 90 tons with a very few Mallet type weighing 124 tons.

There was a comparatively large percentage of locomotives in bad order, and it was estimated by the authorities that in order to replace the worn-out locomotives and meet the requirements for the next 5 years of normal business, Russia will require yearly 2,250 freight engines and 750 passenger engines. There were about 590,000 freight cars, about 13,000 of which are American box cars or gondolas and the balance of them 4-wheel Russian wagons of about 16 tons' capacity.

The car shortage was estimated to be 88,000. The railway shops are old and somewhat antiquated in arrangement and equipment, most of the buildings having been constructed 25 years ago.

The bridges are generally of a good design, being riveted types of structure of German pattern. There are a number of them over 40 years old doing good service. They are kept in good repair, but these very old bridges limit the weight of locomotives which can be operated over them. On the Trans-Siberian Ry. there are some bridges which have seen a service of 33 years. They were designed for very light engines. and the most effective engine in service, the American Decapod, weighing 90 tons, was not permitted to operate over them regularly.

The rails on the Nicholas Ry. between Petrograd and Moscow are about 85 lb., while on the other roads the usual rail was from 65 to 67 lb. The ballast was generally gravel and the road-bed and track were in fair condition throughout. The Nicholas Ry. will compare favorably with the Lackawanna as to service conditions. All the other railways examined were in a good state of maintenance. The standard gage is 5 ft. for all railroads except a few minor branch lines which have a narrow gage of 1 meter. The joints are laid opposite instead of being staggered as in America.

There was no snow trouble for the easterly 2,550 miles of the Trans-Siberian Ry., or for a distance of 400 miles west of Irkutsk; and from that point west there were no evidences from the track or elsewhere that there had been any particular trouble from snow. No snow fences are used except on the Perm and Northern Rys., where a strong growth of brush and timber has been cultivated to act as snow fences. There were no right of way fences on any of the lines which were examined.

The Trans-Siberian line has been very poorly located in detail, except across the Trans-Baikal section and in the valley of the Ob, and it will be quite possible to eliminate at least 50 per cent of the curvature. There were all sorts of reverse curves everywhere and without any apparent reason for their existance. Double track bridges, instead of being single structures, such as we build, were twin bridges—that is, separate bridges placed side by side, with a space of several feet between the. This, of course, is much more expensive than a simple double track bridge such as we build, and all crossings of rivers are made at right angles, which invariably necessitated a reverse curve at each end of the structure.

Apparently 0.8 per cent uncompensated grade has been adopted as the lowest that it is necessary to obtain, except in the valley of the Ob, where they have some districts with a 0.6 per cent maximum. There is a great opportunity in the future for improvements in the lines and grades of the Russian railways—improvements which will result in considerable economy in operation.

**Defects in Operation and Equipment.**—[illegible] Technical Department at Petrograd, and the operating department consisted of a manager on 1,000 to 3,000 miles of railway, and a general car distributor, local car distributors, and station masters, with practically no other men connected with operations. Trains are not dispatched, but handled by station masters, station to station, and are operated by Tape Telegraph Manual Block Signal System on double track, and Staff Block System on single track.. Trainmen have no time tables or train rules, and generally not even watches.

Coal and wood fuel were stored on the ground in piles along the tracks and handled from there to the locomotives by hand. There were no modern coaling stations in service. Much time was therefore lost in fueling. Simple and quickly hand-operated windlasses, a stock of buckets filled with coal and stored on platforms adjacent to the tracks, and wood fuel stored on platforms where it would consume less time to convey it to the tenders, would save at least 20 minutes at each fueling station.

It required from 20 to 30 minutes to water a tender from 4-in, and 6-in. pipes fed from small tanks. By duplicating these pipes or putting in new pipes of 10-in. to 12-in. diameter this time could be reduced to 5 minutes. There were no cinder pits at the terminals, the grates being cleaned on the tracks, also at a considerable loss of time.

The locomotives were not being used so as to obtain from them the greatest possible number of miles' service. The Russian method was to run the engine from a main terminal to a turning point, a distance of from 50 to 80 miles, then returning to the initial point with the same crew, making the round trip of an engine 100 miles between Petrograd and Moscow, and 160 miles between Petrograd and Vladivostok. The time consumed at the turning point, owing to the poor facilities, limits the day's run of one of these engines to one round trip, and owing to the lost time and layoffs the engines make only the small monthly average of 1,500 miles. By operating engines through from one main terminal to another, instead of to a turning point, and by furnishing hostlers to prepare the engine at the initial point and taking charge of the engine at the terminal point, the average monthly mileage for engines would be increased 50 per cent.

**The Chief Recommendations of the Commission.**—The principal recommendations of the commission included:

[illegible]

[illegible] ceived, which were on order in America.

[illegible]

[illegible]

[illegible] locomotive parts received from America

[illegible] tions, thereby saving considerable time in cleaning, coaling and [illegible]

[illegible] pairing broken or worn-out equipment expeditiously

8. Recommendations to our Government that it furnish on priority orders the requisitions of the Russian Government for locomotives and cars.

9. The sending from America of several units of experienced railroad men composed of superintendents, dispatchers, yard masters, train masters, etc., to interest the Russians in the new methods of operation.

The above recommendations were finally approved both by the railway officials and the Government. Orders were issued making them immediately effective and L. A. Ustrugoff was given full responsibility, authority and credits. Locomotives and cars which had been ordered in America were beginning to arrive on priority orders. The United States sent the railway units as requested and the chairman, Mr. Stevens, remained in Russia or in Japan within easy reach of the railway units.

## World's Record for Pile Driving

What is probably a world's record for pile driving was made on June 12 at the Hog Island Ship Yard, when a crew of 11 negroes in charge of Edward Burwell, working for the Arthur McMullen Co., put down 220 65-ft. piles in 9 hours and 5 minutes. The best previous record at the yard was 165 62-ft. piles driven in 9 hours and 15 minutes by the Raymond Concrete Pile Co. In the construction of the foundation for the extension of the Northern Pacific Ry. ore dock at Superior, Wis., described in another article in this issue, the contractors, Siems, Helmers & Schaffner, drove 168 60-ft. piles in 9 hours with a turntable device. In the ore dock work the piles were driven through holes thawed through 4 ft. of ice and in 28 ft. of water.

The equipment used in driving the 220 piles at Hog Island consisted of a Vulcan No. 1 hammer and a skidding rolling machine, with a 3-drum 9x10 hoisting engine. Hammer and hoist were driven by compressed air. The log for the day follows:

7:00 a. m.— 8:00 a. m. .......... 27 piles
8:00 a. m.— 9:00 a. m. .......... 23 piles
(Delay 15 minutes due to broken steam line; raining very hard from 8:15 a. m. to 10:00 a. m.)
9:00 a. m.—10:00 a. m. .......... 28 piles
10:00 a. m.—11:00 a. m. .......... 22 piles
(Delay 8 minutes due to pile fall breaking.)
11:00 a. m.—12:00 a. m. .......... 27 piles
12:00 noon—12:30 p. m. .......... lunch
12:30 p. m.— 1:30 p. m. .......... 25 piles
(Heavy rain with electric showers from 1:25 p. m. to 2:50 p. m. 1:25 p. m. to 1:40 p. m. air pressure dropped considerably, which held up hammer.)
1:30 p. m.— 2:30 p. m. .......... 23 piles
2:30 p. m.— 3:30 p. m. .......... 23 piles
3:30 p. m.—4:35 p. m. .......... 22 piles

9 hours and 5 minutes .......... 220 piles

Total linear feet piles, 14,260. Stopped driving at 4:35 p. m. as shipway No. 6 was completed and there are no remaining piles to be driven on the shipways or piers on Group No. 5. The only piles yet to be driven are fender piles, dolphins, spur piles and a few special piles for derrick footings.

The Burwell crew since it began work at Hog Island in January last has driven 4,131 piles with a total of 241,573 lin. ft. The record of this gang for 6 months follows:

| Month. | No. days. | Piles. | Lin. ft. | Average No. piles per day. | Av. lin. ft. per day. |
|---|---|---|---|---|---|
| January | 10 | 190 | 8,531 | 19.0 | 853.1 |
| February | 11 | 361 | 20,560 | 32.8 | 1,869.1 |
| March | 23 | 711 | 42,730 | 30.9 | 1,857.8 |
| April | 23 | 780 | 47,333 | 33.9 | 2,057.9 |
| May | 27 | 1,470 | 86,173 | 54.4 | 3,191.6 |
| June | 7 | 619 | 36,246 | 88.4 | 5,178.0 |
| | 101 | 4,131 | 241,573 | | |

Average number of piles per day (6 mos.) .......... 42.68
Average linear feet per day (6 mos.) .......... 2,391.82
Average length of piles .......... 58.5

**Skip-Stop Plan for Street Car Operation.**—Beginning Aug. 1 the skip-stop plan of operating street cars in Tennessee will go into effect, and along with it a system of heating cars only when outside temperature is 25° or below.

## Grading and Tracklaying for Logging Railroad with a Ditcher

By using a railroad ditcher for grubbing, grading and for tracklaying, the Potlatch Lumber Co. materially reduced its construction costs and at the same time dispensed with a considerable force of laborers. The methods employed on this work are described by the Railway Review, to which we are indebted for the matter in this article.

Since the main idea in building logging roads is to get the logs to the mill at the lowest possible cost and because the railroad is only temporary in character, considerable latitude is allowed in the construction methods used. Not a great amount of surveying or planning is done in advance for these railroads, the lines being laid out to tap the desired timber land and the ditcher put to work preparing the subgrade.

Where a small amount of filling is necessary the ditcher scoops up the earth alongside the line and dumps it ahead, where it is leveled off by laborers. As the work proceeds the ditcher is moved ahead under its own steam on a portable track built in short sections. Three short sections of track are used, the ditcher standing on two while the third is picked up from behind and swung around to the front with the boom. Ties 10x11 in. x 10 ft. long, and closely spaced, are used, and the sections are braced with diagonal pieces of ½ by 1½-in. strap iron held in place by ¾-in. wood screws and extending from corner to corner of the sections. In case a deep fill is required, to prevent too much of a sag in the track where sufficient earth cannot be reached alongside with the regular dipper, logs are pulled in with the boom to form a portion of the fill, and earth is then placed on the logs to build up the desired grade. In localities where the grading required is slight the timber is logged off the right-of-way, the stumps pulled and the necessary clearing done by the ditcher in addition to making the fill.

Side-hill cuts are made with equal facility, the Potlach Lumber Co. having recently made an 8-ft. cut 300 ft. long on a 6 per cent grade. Fills as deep as 8 to 10 ft. on 4 per cent grades have also been made.

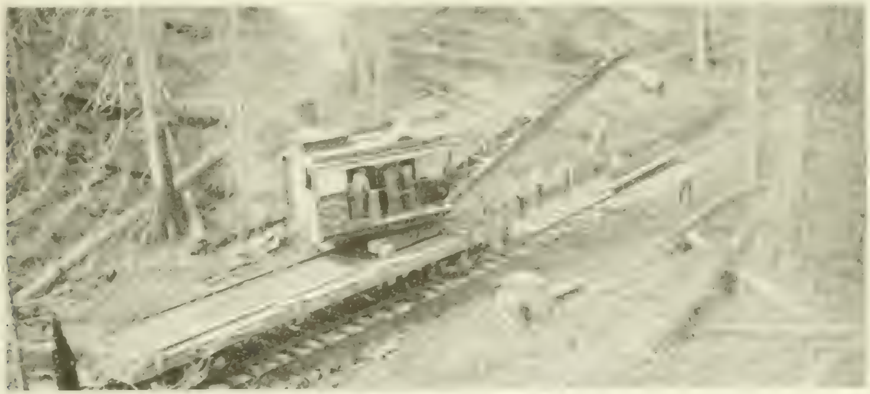
After the grade is completed the machine is run back over the line and mounted on a flat car with steel rails fastened to the deck to permit the necessary amount of shifting of the machine to pick up and handle materials from two cars in rear and place them in the track. In this manner the ditcher is used as a tracklaying machine. The 60-lb. rails, 33 ft. long, are loaded on the car next to the ditcher and the ties piled high on the second car. The dipper boom is removed, so as to allow the use of the machine as a crane, the only extra equipment required being two tie slings made from short lengths of cable with a hook at each end, and a pair of rail tongs.

Two men on the tie car make up bundles of ties which are picked up and swung around onto the grade ahead, where they are distributed, 17 ties to the rail, by a gang of six men. After placing the ties the rails are picked up from the car by center tongs of a special, non-teetering type, a man on the rail car hooking them to the rail. They are then swung around in front and heeled into the angle bars. Two men also put on the bridles to hold the rails in line and to gage until spiked. One man brings the angle bars forward from the front of the rail car and places them on the rails and another man bolts up the joints. One man is employed to carry the bridles ahead, to be used as fast as the rail is laid up to them. These, together with the operator and fireman of the ditcher, make a crew of 16 men required for laying track, the gang being made up as follows:

[illegible]

In placing rails the ditcher, after swinging the rail around to the front, is run out to the end of the flat car on which it operates, so as to swing the near end of the rail slightly beyond the joint. The machine then backs up until the line that holds the rail hangs at a considerable angle, in which position the rail is easily heeled into the joint. The rail tongs are so constructed that they release as soon as the rail rests on the ties.

The spiking crew, working behind the machine, consisted of 2 boilers, 15 spikers and 1 spike peddler, a total of 18 men. Thus the total crew required to complete the tracklaying work numbers 34 men. As much as 3,000 ft. of track have been laid in a day by this crew on heavy grades and where trees on the right-of-way must be cleared off. On straight work, without clearing, it is estimated that one mile of track a day can be laid. By the use of the ditcher in this way the company saves the wages of 25 men at $3.50 a day that would otherwise have been required.



Ditcher Swinging Ties Into Position for Distribution

## Loosening Frozen Coal with Pneumatic Tie Tampers

Pneumatic tie tampers fitted with pointed picks in place of the usual tamping bars were employed very effectively last winter in breaking up masses of frozen coal in unloading hopper bottom cars. At Chicago the tampers were applied to picking frozen ore in cars, clearing mill scale from the chutes at steel mills and breaking up frozen scale in gondola cars. At one point the experiment was tried of applying the tamper against the side of a car of soft coal, the vibration thus set up causing the coal to let go and move out of the car with a rush. In unloading coal the tampers were used after the usual steam thawing had been completed. It was found that the tampers were most effective in frozen bituminous and in the smaller sizes of anthracite coal.

## Accident Prevention in Quary Operation*

Four years ago, at the Hannibal mills of the Atlas Portland Cement Co., we recognized the necessity of organizing our employes in such a way that they would be actively interested by representation in the safety and welfare work at the plant. About this time we organized our Committee on Safety and Welfare.

**Committee on Safety and Welfare.**—The committee originally consisted of three permanent members and six rotating members. The regular members selected were men whom we wished to train thoroughly in safety work and to act as leaders in the general movement. The balance of the members are grouped in lots of two, serving six months each, and after six months two of the members are replaced by two others, so that each year all departments on the plant are represented.

Naturally, departmental foremen were the first men selected, but, after operating the committee for four years, we now have the opportunity of training the general employes as well as their foremen. An alternate is appointed to serve in the absence of his regular representative and in the course of time it is usual, as vacancies occur, for the alternate to receive appointment as a regular member on the committee. As members of the committee we endeavor to select men who have in some way, by suggesting safety practices or otherwise, indicated to their foremen that they are interested in safety work.

**Work of Committee.**—We have created throughout the plant the desire on the part of all men to become members of the Safety and Welfare Committee. This desire may in part be due to the fact that, upon being appointed to the committee, they are presented with a gold button symbolic of safety and welfare work. At the committee meetings are presented the various pamphlets which are issued by the Portland Cement Association and the National Safety Council, reports from the other plants of the Atlas Portland Cement Co., and a summary of the accidents at the local plant. The latter is carefully studied and the chairman of the committee appoints sub-committees to investigate and report upon certain accidents of an unusual nature.

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*[illegible]

Lectures on first-aid work are occasionally given, and the general plan is to keep the men thoroughly interested and enthused in the work so that each year we may turn out into the plant a few men that look upon "Safety First" as a responsibility instead of a mere slogan.

**Enforcing Rules for Safety Measures.**—There are places around some machinery which cannot be adequately protected by a guard, and when such places are encountered it is necessary to instruct, caution, or discipline against any unsafe or dangerous practice on the part of employes. We have found that certain guards are cumbersome and impracticable from an operating and maintenance standpoint, and when such is the case it is necessary to adopt and rigidly enforce rules against violating such measures.

When a safety rule is violated the disciplinary measure meted out to the employe sets an example before his fellow workmen which is of greatest value. We do not always find it necessary to discharge a man, unless by repeated carelessness he places not only himself but his fellow workmen as well in constant danger. For a first offense the man is instructed by a member of the Safety and Welfare Committee how to avoid a repetition of a careless act. On a second and third offense the man is disciplined by a lay-off of from 3 to 10 days. This usually suffices, and the man tries to protect himself as well as his fellow workmen, but occasionally a case comes up where we find, for the good of the service, it is necessary to discharge the offender.

Men who have been in the service for some time, through the routine of their duties, neglect necssary precautions and are apt to become careless around the machinery with which they have become familiar. The newer employes are not so apt to run into these heavy hazards, because they are naturally somewhat afraid of the heavy machinery in the plant, but due to their lack of knowledge of the possible hazards they do run into a lot of injuries in the handling of miscellaneous small objects, receiving minor bruises, burns and sprains. We take particular pains to instruct new men before putting them into the plant.

We have given particular attention to the guarding of shovels, gears especially being well guarded according to best practices. We particularly insist on steam shovel engineers making a careful inspection to see that everything is in good condition before operating and that no one is in the pit. No one is allowed to pass in front of the shovel while loading cars.

**Picked Men for Extra Hazardous Work.**—Of the number of men in the quarry, at least 75 per cent are engaged in operation such as stripping, drilling, blasting, hand loading, pit work at the shovels, track work, and general labor. We pick out men with the greatest possible care for the more hazardous work of loading holes, blasting, and hammer drilling under heavy banks. We instruct these men constantly, for we realize that by carelessness, in handling dynamite or drilling a block hole in a large rock—which may not be too well anchored—and similar work, they may cause injury to a large number of men. We try to instill in our men the thought that dynamite is made to go off and it may do so with the slightest bit of careless handling.

I believe the greatest hazard in any quarry is the constant danger of an accident involving a large number of men. This may come from a premature explosion of dynamite, especially if men are allowed to work in front of a bank which is being prepared for blasting. We take particular precaution against this danger, not only by careful supervision of the work, but the enforcement of disciplinary measures upon the men who violate any of our well-established rules.

**Night Operation of Quarry.**—I am not informed as to how many quarries operate at night, but at Hannibal we follow this practice and have been successful in keeping the number of night accidents down to a minimum. Night operation in a quarry requires good illumination at the shovels. On account of the constantly changing positions of shovels, it is not always feasible to illuminate the pit with electric lights. We formerly used heavy-power lump carbide lamps, but the large-lump carbide generators are dangerous. We have been using, during the last year or so, a type of lamp which utilizes carbide in a compressed cake form. This cake is placed in a bell and by an ingenious arrangement the water is entirely withdrawn from the cake when the light is turned off and thus the gas does not continue to generate and permeate the atmosphere surrounding the tank with carbide gas which may be exploded by the lighting of a match close to the tank. Entire absence of gas around the tank at all times is a distinct safety feature in the use of this lamp.

**Precautionary Measures in Moving of Raw Material.**—In moving raw material from the quarry there are one or two precautionary measures that are necessary to follow up closely. One is to keep employes off the tracks and the other is to make the switchmen careful in handling cars. It is rare practice now to see a switchman open a coupler with his foot, but it was not so very long ago that the switchman seemed to enjoy waiting until the cars were about 5 ft. apart, then preparing the couplers for proper connection with one of his feet. Switchmen should particularly be cautioned against running ahead of moving cars in order to throw a switch. We try to teach them that they should at all times keep within the range of vision of the engineer—this for their own protection.

**Safety Appliances.**—Where guards are used over gears, such guards should have sides to include the full depth of the teeth, and where spoke gears are close to platforms and passageways the sides should be protected. Railings for rear guards or along moving machinery should be a suitable distance from such machinery or else have a screen or solid guard along the side. Railings, wherever constructed, should be 42 in. high, with at least 6-in. boards. Posts should be of sufficient strength and well secured at the base.

All overhead platforms, floor openings and runways should be provided with properly constructed railings; should be kept clear of any obstruction or loose material which may be thrown down on the floor below or into moving machinery. All open stairways should have railings on both sides, the top rail should be 36 in. above tread. Closed stairways require only a single hand rail. Stairways over 43 in. wide should have an additional railing through the middle of such stairway. Portable ladders should be provided with a tip to eliminate danger of slipping. Ladders used to get at overhead shafting should be provided with a substantial hook to fit over the shaft. Wooden ladders should have rungs substantially housed into the side rails and protected by a strip along the face of the sides to prevent the rungs from pulling out. Vertical ladders should have a good clearance between the center of the rungs and wall and where long ladders are used landings should be provided at proper intervals.

**Guards for Chains and Belts.**—Wherever sprocket chains are so located that in breaking they may fall on platforms or into moving machinery, and particularly where they are above passageways, they should be guarded by a solid guard on the sides and bottom. We all know that sprocket chains are usually removed because they break. We have found on certain drives that whenever a chain breaks at certain definite intervals, say within six months, it is a good plan to replace the chain in, say, four months, as the loss due to a choke by the breaking of a chain is more expensive than getting shorter life out of the chain. Chains that are taken off can, of course, be used on less important drives and this is a good practice to follow. It is also safer to remove the chain than to allow it to break. Belts running through floors, or vertical belts, should have guards to a point about 6 ft. above the floor. All horizontal belts should have guards to eliminate danger of men walking into such belts.

All bearings and parts of machinery requiring oiling or other attention should be provided with means of applying the oil or other material safely. This can be accomplished by piping bearings to the side or to a nearby platform.

A screw conveyor is about as dangerous a piece of machinery as we have around the plant and rules should be enforced to keep men off the conveyor tops. In repairing elevators, particularly when a link or bucket must be removed or replaced, provision should be made for keeping the chain from rolling back.

There is so much safety work to be done in any plant that we endeavor not to attack unnecessary places, but concentrate our attention on guarding of such machinery which presents a real hazard. Further, guards are very often more dangerous than the machinery itself, for often a man will neglect to remove a portable guard before attempting repairs; therefore, in installing guards, particular attention should be given to constructing them in such a way that the machinery is accessible, or, if possible, to so arrange the guard that it can be readily removed before any maintenance work is attempted.

Railings may often be used to better advantage than guards. In cases where there is a possibility of a man walking into machinery, a railing is installed to keep him away from that particular place. These railings prove to be especially valuable in preventing short cuts that men are likely to take in the performance of their duties.

It is of the greatest importance that foremen, particularly, be carefully instructed on safety work, as through the foremen we endeavor to instill among all employes the interest and importance in this great work. At the meetings of our Safety and Welfare Committee we get many suggestions and ideas from employes, and we endeavor to follow up any good suggestion. We find that the man usually watches the work closely and greets with pleasure and satisfaction the final adoption of a measure which has been the growth of his own idea.

**Guarding Against Electrical Hazards.**—The replacing of steam with electric power gives rise to conditions which previously did not exist. Formerly it was only necessary to guard against electrical hazards at low voltage. Power is now received at our plant at 33,000 volts, and a large part of it is distributed at 2,200 volts. The distribution is accomplished by remote control from a single switch gallery under the supervision of a chief operator, through whom all switching operators are forwarded.

The switchboard operates at 110 volts, the 2,200-volt oil switches being in a bus room below the gallery. Each oil switch is isolated by asbestos barriers and red and green lights are used to indicate whether the line is in or out of service. Carefully drafted rules have been instituted regarding safe and efficient operation. Each operator is supplied with explicit instructions and a code must be used in transmitting switching orders, all of which are repeated back in order to avoid the possibility of a mistake and consequent danger to life and property.

We follow the general practice of marking switches to indicate that the machinery is out of service. We record on the tags the time, date, reason, and name of person who ordered the line to be held. Very often more than one motor is used in a certain operation, and in such case the sequence and order of starting and stopping such motor is posted and the switches likewise numbered. All electrical machinery is carefully and adequately supplied with emergency trip-out and time-limit relays.

In working around electric equipment men are instructed to treat all circuits as live, as the insulation may be defective, and that they should not touch motors or related apparatus when they are in operation, but should play safe at all times. Shocks even from grounds are disagreeable and flashes cause serious copper burns as well as injuries to the eyes. Circuit breakers should never be thrown when switches are closed and before closing them it should be noted that the starting box handles are all down. There is a possibility of the circuit breakers opening at any time and for this reason it is well to keep away from them to avoid flashes. In stopping motors, circuit breakers should always be tripped first. Our men always guard their eyes in tripping a circuit breaker and when starting a motor they keep away from the commutator as a flash-over may occur at any time.

While we believe we have taken every possible precaution against injury to employes from electrical equipment, yet there is the ever-present danger that cannot be entirely eliminated. All operators in the power department are thoroughly instructed in the Schaeffer or prone-pressure, methods of resuscitation. We also have, in our emergency hospital, a lung-motor which is readily available for prompt use.

## Blasting Boulders Without Drilling

A 12-ft. long, 7-ft. wide and $7\frac{1}{2}$-ft. high boulder on a farm at South Byfield, Mass., was disposed of by the following method: The first operation was to dig down in the frozen ground alongside of the boulder to a depth of about 2 ft. This was made easier by using a stick of dynamite in a borehole to break up the frozen soil. Standing in this first hole, the blasters then tunneled under the boulder for a distance of about 5 ft. At that point they came to a shelf upon which the charge of dynamite was packed. The earth was then packed carefully back into the hole so as to leave the ground approximately as solid as it had been before the digging disturbed it. In doing this care had to be taken not to pull the cap and fuse out of the charge of dynamite. The result of the shot was the breaking up of the stone in pieces so small that any single piece could be hauled away by a two-horse team. The entire job was done in one blast, in which $17\frac{1}{2}$ lb. of 40 per cent dynamite, one cap and about 8 ft. of fuse were used. The dynamite was a low-freezing variety which gave no trouble in spite of the fact that it was 15° below zero when the work was done.

# Comparative Analysis of Gravel Screens

By RAYMOND W. DULL.

**The Inclined or Gravity Screen.**—A screen in its simplest form is the inclined plane or gravity screen. The main difficulty with this type of screen is that the material after traveling a few feet accelerates to such a velocity that the holes in the screen are passed over by particles which should pass through. The length of the effective travel is very short and the results obtained are very unsatisfactory.

Engineers might say, why not make the shape of the screen or curvature of the path such that the velocity is constant or uniform and without acceleration? Fig. 1 is referred to as a possible curve for such a screen. Let A—B represent the curve and our problem is to find the shape of the curve or its equation.

The acceleration of a particle passing down an inclined plane without friction is g sin $\theta$, where $\theta$ is the angle of the inclination with the horizontal. The retardation due to friction or negative acceleration is gf cos $\theta$ when f = coefficient of friction. Therefore, the acceleration of the particle passing down the plane at any instant is

$$g\ (\sin\theta - f\cos\theta)$$

Now since we desire maintaining a uniform velocity without acceleration

$$g\ (\sin\theta - f\cos\theta) = 0$$

$$\sin\theta = f\cos\theta$$

$$\frac{\sin\theta}{\cos\theta} = f = \tan\theta$$

The result shows that the curve resolves itself into a straight line the tangent of which is equal to the coefficient of friction. In other words, if the screen is set at the angle of friction the particle will slide down the screen at the same speed at which it started. Unfortunately, we have quite a variation in the coefficient of friction, for some particles will slide down while others will roll down. Therefore, by setting the screen for the former will result in giving the latter considerable acceleration. Another difficulty with this type of screen is that particles will lodge in the holes of the screen and block the screen unless removed by some means.

**The Cylinder Screen.**—The cylinder screen is the oldest type of revolving screen in use. They are set at a slightly downward slope to cause the material to travel through the screen. The path of the particles on the screen surface is a helix. In order to determine the pitch of the helical path of the particle in a cylinder screen we will assume a certain angle ∝ as the inclination of the screen with the horizontal. Every element of the screen surface parallel to the axis will have this angle with the horizontal, assuming that these angles are taken in vertical planes.

First assume a horizontal plane with the line A O in that plane. (See Fig. 2.) Assume that the vertical plane through A O is rotated about A O through an angle of 90° or into the horizontal plane. Now draw C A O equal to ∝ then C A represents an element of the cylinder. Next draw C B O equal to

$$\theta = \tan^{-1}\frac{C\,O}{O\,B} = \text{angle of friction.}$$

We know that the particle will travel in some direction in the normal plane which has an instantaneous angle of $\theta$ with the horizontal plane. Rotating B C A back again into the vertical plane about B O A as axis, we will determine the intersection of the normal plane with the horizontal plane and rotate the normal plane about the line of intersection into a horizontal, and determine the true angle which the path makes with the cylinder element. Rotating O B about vertical axis, O making the arc B D, and draw A D tangent to the arc, A D is the line of intersection of the normal plane and the horizontal plane. This also establishes the direction of the path of the particle or O D which forms the angle A O D of a vertical plane passing through O D and another through A O measured in horizontal plane.

In order to get the true angle with the cylinder element it is necessary to lay out the angle $\theta$ as O D E and rotate the normal plane into the horizontal plane about A D as axis, which gives us A F D or $\Phi$ as the true angle which the path of the particle makes with cylinder element.

To reduce this analytically in terms of the given angle, we have

$$C\,A = A\,F = \frac{C\,O}{\operatorname{Sin}\propto}$$

$$C\,B = D\,F = \frac{C\,O}{\operatorname{Sin}\theta}$$

$$\operatorname{Cos}\Phi = \frac{D\,F}{A\,F} = \frac{C\,B}{C\,A} = \frac{\dfrac{C\,O}{\operatorname{Sin}\theta}}{\dfrac{C\,O}{\operatorname{Sin}\propto}} = \frac{\operatorname{Sin}\propto}{\operatorname{Sin}\theta}$$

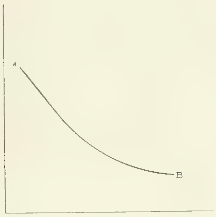

Fig. 1.

Fig. 2.

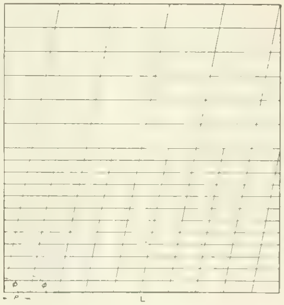

Fig. 3.

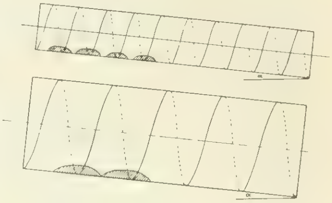

Fig. 4.

$$\Phi = \text{Cos}^{-1}\frac{\text{Sin}\ \alpha}{\text{Sin}\ \theta}$$

In order to compute the length of the helix, we will develop the surface of the screen and indicate the path of the particle. (See Fig. 3.) The pitch P of each turn of the spiral $= \frac{\pi D}{\tan \Phi} = \frac{\pi D \cos \Phi}{\sin \Phi}$

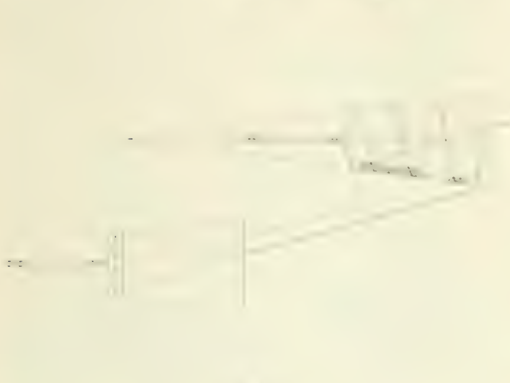

Fig. 5.

Length of each turn of spiral $=$

$$\frac{P}{\cos \Phi} = \frac{\dfrac{\pi D \cos \Phi}{\text{Sin}\ \Phi}}{\cos \Phi} = \frac{\pi D}{\text{Sin}\ \Phi}$$

$$\text{Number of turns} = \frac{L}{P} = \frac{L}{\dfrac{\pi D \cos \Phi}{\text{Sin}\ \Phi}} = \frac{L \sin \Phi}{\pi D \cos \Phi}$$

Fig. 8.

Total length of spiral = length of turn × number of turns $= \frac{\pi D}{\sin \Phi} \times \frac{L \sin \Phi}{\pi D \cos \Phi} = \frac{L}{\cos \Phi}$

But $\text{Cos}\ \Phi = \frac{\text{Sin}\ \alpha}{\sin \theta}$

Total length of spiral $= \frac{L \sin \theta}{\text{Sin}\ \alpha}$

Assume $\theta = 45°$ and $\alpha = 7°$

we would have length of spiral $= \frac{.707\ L}{.1219} = 5.8\ L$

It therefore follows that the length of travel in a cylinder screen is independent of the screen diameter, but simply depends on the length of the screen and the inclination of its axis. This fact no doubt will be a great surprise to many, including screen manufacturers, for screens of large diameter are usually given considerably higher rating than they should have. The length of the travel of a particle in a screen 36 in. diameter and 12 ft. long is identical to the path of a particle in a screen 72 in. diameter and 12 ft. long, if both screens are set at the same inclination. This path is about 70 ft. long. The advantage of the large screen, however, is that the distance between the coils of the helix is greater, which allows the material to spread out more and make a wider helix. See Fig. 4.

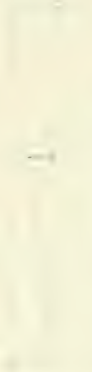

Fig. 6.

Fig. 7.

Fig. 9.

Fig. 10.

**Overhung Conical Type of Screen.**—We will next take up a type of screen used a few years ago quite extensively in gravel washing plants. It is known as the overhung conical type. Fig. 5 illustrates the screen and the manner in which they were used.

To determine the angle of advance of the spiral, we will assume line A B, Fig. 6, as the intersection of curved plane drawn tangent to the screen and forming angle of friction with a horizontal plane. Draw A C equal to M O of Fig. 5, then draw C D, making angle C D A = $\alpha$ = angle of friction. Draw D E parallel to A B, making length A E equal to M N in Fig. 5. Then E A B (Fig. 6) is equal to angle of advance of the helix. This is evident by assuming that the normal plane is rotated into the horizontal plane. The element A E and the axis are then in a vertical plane through A E and the perpendiculars to A B and A E give the angle of advance and by geometry would be equal to angle E A B.

To trace the path of travel it is necessary to develop the surface of the screen cone. The path then takes the curve of the logarithmic spiral as shown by Fig. 7 and when drawn in on the cone takes the form as shown by Fig. 5.

The length of the spiral is $\dfrac{R - r}{\cos\,(90^\circ - \Phi)}$ where R is the length of the cone element A E from the apex to the large diameter of the cone and r the cone element from apex to small diameter of cone and Φ the angle of advance of the spiral just found.

Assuming the same slope for the screen as taken for the cylinder screen, we find that the angle of advance is approximately 10° and $R = 18.18$ ft., r 12.1 ft. $\cos 80^\circ = .1736$, and the length of spiral is 34.7 ft. for a cone screen 72 in. long and 1½ in. per foot slope. This is practically the same length of travel for a cone screen as cylinder screen 72 in. long. This would naturally be expected since we found that the diameter of the cylinder screen did not affect the length of the path of the travel of the particle.

The form of the logarithmic spiral formula is $r = aE\,m\Phi$ and by use of hyperbolic logarithms the curves of Fig. 7 are plotted.

**Inclined Conical Screen.**—The screen which we will next discuss is the well-known inclined conical screen, which is mounted on the same shaft as shown by Fig. 8. The material in this screen travels ahead while the screen shown by Fig. 5 has a backward flow. These screens have an entirely different taper than the other style and are designed to give the best pitch of the spiral and a minimum pitch for the flume from screen to screen. These two angles, together with the given diameter of the large end of the screen, determine the shape of the cone.

A different diagram is necessary to determine the angle of advance of the helix as well as the path of the particle.

Assume line O A as the intersection of a vertical plane through the screen or cone axis and a horizontal plane through the apex O. Draw O B, making angle of friction with line O D, which is at right angles to O A. We next locate E, knowing that it is equal to N P (Fig. 8) from B O and a distance P H (Fig. 8) from D O. Now drop a perpendicular E H to B O and rotate H O into O D. We now have the screen element in the horizontal plane and can lay off element M N (Fig. 8), as D J or as H K before rotation about O A. The axis of the screen is in the vertical plane through O. L. Rotate the vertical plane about O A in figure to right in diagram and we have O L as the axis and K O as the projected co-ordinate of the element. Assume a point as M and draw M N perpendicular to O L or cut the element with a perpendicular plane. Now transfer the intersection of this plane with the normal plane through the element and we are ready to rotate the normal plane into the horizontal plane, which gives us the true angle advance of the helix or Φ.

The helix can then be drawn as shown by Fig. 10 in same manner as before except in the reverse order. We find that the length of this helix has the same length provided the pitch of the helix is the same, but usually the pitch is a little less and the path a little longer.

We now come to the most interesting analysis of these paths.

The cylinder screen has a spiral with uniform distances between the coils. When a quantity of material is introduced into the screen it can spread, depending on the distance between the spirals. The greater the diameter the greater the spread. Now as the material travels through the screen and the amount gets less and less since the greater portion goes through, we must overcrowd the screen at the start or we are not using the full width between the coils at the lower end.

The screens illustrated in Fig. 5 have the helical paths close together at small end and the discharge between the corresponding points on the helix, or pitch of spiral increases toward the large end of the screen. The material is delivered to the small end of the screen where the material can spread the least amount, yet this is the point of maximum quantity of material in the screen.

It is, therefore, necessary to crowd the small ends of these screns to make use of the wider path at the large end of the screen. In other words, the increased pitch of the helix is in the wrong direction. The piling up of the material at the small end interferes with the pebbles passing through the openings and a large per cent of the screen area is lost.

The screens shown in Fig 8 have the wide helical path at the large end where the material is received. The paths get nearer together as the material travels along. The quantity also becomes less and less. In this screen the spirals are in the right direction and the efficiency is much higher.

The cost of screens is proportional to the area of screening surface. Another consideration in comparing screens is the correct speed for screens. It has been found by experiment that a surface speed of from 175 to 200 ft. per minute is the most efficient; if slower than this the capacity is cut down and if faster the screening efficiency is lowered because the pebbles do not have sufficient time to go through. With the cone screens the speed should be computed for the large end, for if speeded according to small end the speed of large end would be excessive.

This results in a further cut of efficiency in screen Fig. 5, because the bulk of the material is at the small end where the screen speed is greatly reduced, while with the screen Fig. 8 the correct speed is at the large end where the greatest quantity of material is received while the decreased speed of the small diameter does not cut down capacity much because the quantity of material is then so small.

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**U. S. Labor Board Asks Present Wages Stand.**—No more changes in present standards of wages, hours and conditions of labor by any Government agency is urged by the War Labor Policies Board, pending a uniform standardization for the Government now under consideration by the board. This is the gist of a resolution by the board, announced last week, directed to all departments of the Government, advising that all wait on unity of action concerning Government labor.

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The Boston & Maine R. R. contemplates expending $22,000,000 for terminal improvements, betterments and equipment.

# Levee Construction in North Texas with Draglines

By O. W. FINLEY,
Levee and Drainage Engineer, Dallas, Tex.

Texas for the larger part is a more or less level country and in consequence many of the streams have very wide overflow areas. Few of these streams have channels sufficient to carry more than 25 per cent of the water at flood stage. Take the Trinity River (on which most of the reclamation work is now in progress) as a fair example. It has been determined by actual measurement that the channel carries not more than 20 to 25 per cent of the flood water during high rises. During the flood of 1908, one of the highest, about 125,000 cu. ft. of water per second passed down the stream. Since the channel measures only about 200 ft. at the top, 100 ft. at the bottom and averages 27 ft. deep and has a fall of approximately 1¼ ft. per mile, it will be readily seen that 75 to 80 per cent of the water must find some place other than the channel in which to flow. This is taken care of by wide bottoms or overflow areas which on the above mentioned stream range from 3 to 8 miles wide from hill to hill. These overflow lands are flat and wooded and the soil is composed of silt and sediment deposited by floods since Texas became dry land and is extremely fertile. It is very black and sticky and will grow almost any kind of farm products in abundance.

Bucyrus Drag Line Constructing 18-Ft. Levee in Dallas County District No. 2.

There are enormous areas of this land only awaiting reclamation from floods to become the most productive and highest priced land in the South. According to an accurate survey of Trinity River by the United States Engineering Corps, there are 667,295 acres of overflowed land on this stream alone and not including the tributaries, of which 7 per cent is in cultivation and 60 per cent is probably reclaimable. This survey includes the area from Dallas to the Gulf of Mexico, an airline distance of 250 miles. Taking into consideration the East Fork, West Fork and Elm Fork of the Trinity and the numerous large creeks, the total flooded area of the Trinity Valley would probably exceed 750,000 acres. This is the only stream in the state on which a survey has been made and the only one on which accurate data are obtainable. Considering that the Brazos, Colorado, Navasota, Sabine, Neches, Angelina, Sulphur and Red Rivers are all large streams, the generally accepted estimate of 3,000,000 acres of overflowed lands in Texas is too conservative, I think, by 1,000,000 acres. As an example, take Ellis County, which has 29,000 acres of overflowed land either reclaimed or in process, 23,000 acres is on the river and 6,000 on the tributaries or creeks, and Ellis is not a flooded county, either, as there are probably 30 counties in central and east Texas having more overflowed territory.

The land is reclaimed by building levees on each side of the stream and sufficiently far from the channel to carry the flooded water in excess of the channel capacity plus a good per cent for safety. On the Trinity these levees are placed from 800 to 1,000 ft. from the center of the channel and are from 14 to 20 ft. high. By thus confining the flood waters between levees, the larger part of the inundated land is reclaimed and placed in condition for farming.

The first levee work of any magnitude was begun in June of 1914 when a levee 10 ft. high and 44,000 ft. long was built on Trinity River for the protection of

TABLE I.

| No. | Make | Propulsion | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|---|---|
| [illegible] | No. 1 [illegible] | Walker | [illegible] | [illegible] | [illegible] | [illegible] |
| 1 | No. 2 Monighan | Walker | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | No. [illegible] Monighan | Walker | [illegible] | [illegible] | [illegible] | [illegible] |
| 1 | [illegible] | Skid and roller | [illegible] | [illegible] | [illegible] | [illegible] |
| 1 | Bucyrus | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

TABLE II.—LEVEE IMPROVEMENT DISTRICTS IN NORTH TEXAS

| Name of District | Acreage | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|---|---|
| Dallas County, No. 1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Dallas County, No. 2 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Dallas County, No. [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Dallas County, No. [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Dallas County, No. [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Delta County, No. 1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Delta County, No. 2 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Ellis County, No. 1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Ellis County, No. 2 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Ellis County, No. 3 | 9,200 | 170,000 | $65,000 | $55,700 | 10 | 1 |
| Ellis County, No. [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Ellis County, No. [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Ellis County, No. 8 | 1,215 | 37,500 | 280,000 | 272,310 | 10 | 1 |
| Ellis County, No. [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Ellis Co. No. [illegible] and Navarro No. [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Franklin County, No. 1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Henderson, No. 1 | 5,200 | 200,000 | 1,846,000 | 520,182 | 9½ | 1 |
| Kaufman County, No. 1 | 9,010 | 125,000 | 821,257 | 821,257 | 10 | 1 |
| Kaufman County, No. [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Kaufman County, No. 4 | 14,560 | 250,000 | 1,500,000 | 0 | .. | 0 |
| Kaufman County, No. [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Navarro County, No. [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Navarro County, No. [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Navarro County, No. [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Navarro County, No. [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Navarro County, No. [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Red River, No. [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Total | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] |

Note.—Many other districts [illegible]

9,040 acres of very fine black flood land in Kaufman County; this levee has since been raised to 18 ft. height. The levee was constructed by an old steam skid and roller drag line machine which has long since been junked and has now been replaced by 18 new machines, 15 of which are Monighan gas walking machines, one a Bucyrus mutipedal, one a gas skid and roller and one a steam skid and roller. The 18 machines are of the following types and sizes:

All the small machines have vertical triple cylinder gas engines while all the larger or No. 2 and 3 machines, except the Bucyrus, have horizontal single cylunder gas engines. The Bucyrus has a triple vertical type engine and is an excellent dirt mover.

Up to May 18, 1918, a fraction more than 100 miles of levee had been built in which had been placed 6,540,000 cu. yd. of earth. Seldom more than 15 of the machines are working at the same time, the others are moving from one job to another, but nearly 500,000 cu. yd. are being moved per month, or an average of about 30,000 yd. for each machine. The larger machines sometimes run over 60,000 yd.

It will be noted from Table No. II that the cost of reclamation varies from $14 to $70, the latter figure being an extreme. The cost varies with the height of the levee, cost of right of way, and number of acres reclaimed per mile of levee or width of overflow area behind the levee. But the value of these lands advance so rapidly and their productive capacity is so great that almost any amount up to $100 per acre would be a profitable investment expended in reclamation. It will be seen, however, that by leaving out the one extreme example, the Ellis No. 9, the average cost per acre is a little more than $25.

To give an idea of the advance of these lands, I have secured a signed statement from the leading man in each of five of the first districts protected, which tabulated are as follows:

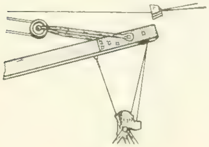
TABLE III

| District. | Area, acres. | In cultivation. 1912. | 1918. | Houses built since 1912. | Av. value. 1912. | 1918. |
|---|---|---|---|---|---|---|
| Dallas, No. 2........... | 4,800 | 3,200 | 4,000 | 20 | $40 | $125 |
| Ellis, No. 1........... | 5,000 | 2,500 | 4,500 | 25 | 40 | 125 |
| Ellis, No. 1........... | 925 | 275 | 850 | 10 | 40 | 125 |
| Dallas, No. 1........... | 3,300 | 1,200 | 3,000 | 40 | 25 | 125 |
| Kaufman, No. 1...... | 9,040 | 2,000 | 8,100 | 80 | 20 | 125 |

This table can be verified by any number of actual sales and recorded deeds. As would be expected there are many tracts in these districts that cannot be bought for $150 per acre while there are places along sloughs and low places that are not worth much.

The rise in value is still in progress and will continue for years to come. By comparing the 147,000 acres now protected or being protected with the estimated amount of 3,000,000 acres of flood land in the state, it will be seen that we are just starting this great work.

## Preventing Twisting of Bucket Line on Low Boom Work



The arrangement shown in the sketch was devised by a ditch contractor for preventing his clam-shell bucket line from twisting on low boom work. The dead line passes around the bucket sheave and is anchored to the boom far enough from the boom sheaves that the weight of the bucket itself keeps it from turning.

## Equipment and Steam Shovel Cuts in Stripping on Mesabi Range

Methods employed in stripping on the Mesabi Range of Minnesota have undergone many changes since the beginning of operations. The changes in equipment are summarized by Mr. L. D. Davenport in the first of a series of articles on Steam Shovel Mining on the Mesabi Range in the Engineering and Mining Journal, from which the following notes are abstracted:

The first stripping work on the Mesabi Range was done with teams and scrapers or the material was loaded by hand into wagons. Later 1 cu. yd. cars running on light rails were loaded by hand and hauled by team. The next step was the "dinkey" equipment with 8 to 15-ton locomotives and ½-yd. shovels.

This type of equipment was used until larger shovels having dippers of 2-cu. yd. capacity were introduced, when the 36-in. gage dinkey locomotives and cars were replaced by standard-gage equipment. One striking feature in connection with the increase in size of equipment is the decrease in the number of men employed on the stripping dumps.

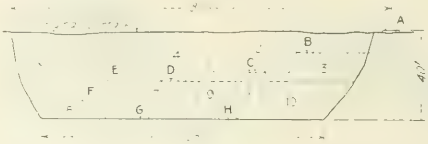


Fig. 1—Cross-section of Cut Made by Model 300, and Cuts Required to Remove Same Area With Model 91 Shovel.

The first dinkey equipment required a dump crew of 50 men, whereas with the present use of large dump spreaders, and 20-yd. cars, only two men are needed.

Fig. 1 shows a cross-section of a single cut taken with a Model 300 steam shovel weighing 360 tons and with a 6 to 8-yd. dipper. The loading track was laid in the surface of the ground as shown at A, and on this particular cross-section the great shovel had sufficient reach to push the accumulated spill from the cars clear of the further rail of the loading track.

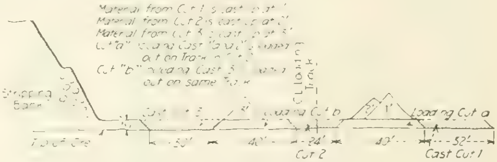


Fig. 2—Cross-section Showing Method of Removing a Shallow Clean-up With Model 91 Shovel.

The divisions marked from 1 to 10 show the cuts that would have been necessary had the same cross-section been removed with a Model 91 shovel weighing 107 to 123 tons and having a 2½ to 4-yd. dipper, and the loading tracks for the different cuts are lettered from A to H. Track A is the loading track for the first cut, track B for the second cut, track C for the third and fourth, and so on.

The method of reinforcing a shallow cleanup with a Model 91 shovel is shown in Fig. 2.

# Employment of Divers in Shaft Sinking*

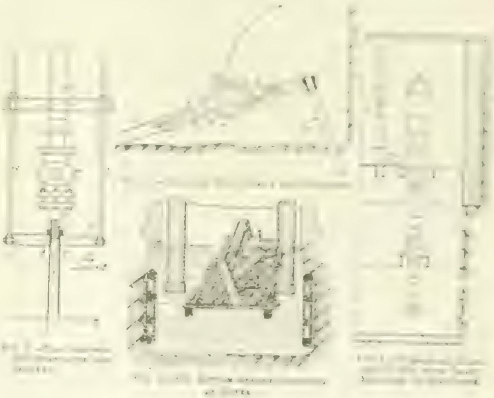
Of late years the employment of divers in shaft sinking has proved very useful for a number of purposes in the Bochum district, including the fitting and removal of pump strainers, the examination and freeing of sinking shoes, overhauling shaft pumps, replacing cables disturbed by the influx of water, etc.

**Removing Obstruction from Casing of Borehole.**—At one pit in the Witten district, when the shaft had been carried down to about 25 yd., a feeder discharging some 250 gal. of water per minute was tapped at about 125 yd. by a 12-in. borehole in the shaft bottom, this hole being kept open by a wire rope which could be raised or lowered from bank or from the shaft bottom. The casing inserted in the borehole in its upper section, which passed through loose rock, was closed by a fluted, taper wooden plug, a certain amount of water being allowed to escape through the grooves in the plug and perforations near the top of the casing. When the lower portion of the shaft was being lined with concrete a pile of rough stones was made round the projecting end of the casing; and, to facilitate the setting of the concrete and maintain a counter pressure in the interior of the shaft, the water was allowed to rise nearly to the level of the staging. Owing to some of the concrete having run down into the pile of stones, the wooden plug was found to have jammed, and could not be pulled out; and the water rose to within about 16 ft. of the bank, the shaft being completely flooded.

A diver was sent down for several days to recover the skips and other articles on the shaft bottom, and more particularly to break up the cemented stone pile round the casing, so as to free the plug and the mouth of the borehole. The plug being nearly 5 ft. long, and extending for over 3 ft. into the casing, it was decided to bore it out. To provide proper guidance for the boring bar, 65 ft. in length, a 2½-in. pipe was let down, the lower edge being provided with sharp teeth so as to get a good grip into the top of the plug, the diver holding it in position until the boring tool was deep enough into the plug. Through the 1½-in. hole thus formed the water was allowed to run for several days, at the end of which time, however, another stoppage of the borehole occurred and necessitated the aid of the diver in boring through the plug again. The borehole was then flushed out thoroughly, and a rod, composed of railway rails lashed together, was lowered into it and suspended from an iron girder on the shaft bottom, so that as sinking progressed, the girder and rod descended automatically by their own weight and prevented the hole from choking up again. This done, sinking was continued without any further water troubles.

**Use of Divers in Unwatering Coal Mines.**—During the difficult operation of unwatering the State colliery at Waltrop divers were frequently employed. At first an attempt was made to cope with the extensive inrush of water—amounting to nearly 4,000 gal. per minute—by means of Tomson water barrels. In carrying out this plan much trouble was experienced with the flat winding ropes used, these being severely strained by the great weight of the ropes themselves and the full barrels, and jamming in the winding bobbins. Moreover, when little progress could be made in lowering the water level, the repeated splashings of the saline mine water every time a water barrel was lowered acted on the pitchpine guides and softened the timber, which then easily broke. This enabled repairing the guides under water, the divers having to work at a depth of about 70 ft. Eventually, however, the work of unwatering with barrels had to be given up, owing to the above mentioned rope troubles, and carried out by means of mammoth pumps, arranged in series.

**Plugging Standpipe of Borehole Casing.**—Considerable practical importance attached to the work done by divers in sinking two shafts by the cementation process, one of them being driven through the fissured white marl of the Recklinghausen district. When this shaft had got down to a little over 500 yd., and was only some 150 yd. from the coal measures, one of the advanced boreholes struck the powerful feeder. As there was no stuffing box on the standpipe of the borehole casing, and as the rods, forced up by the rush of water, jammed against the staging near the shaft bottom, it was impossible to cap the pipe, and the shaft soon became flooded to a depth of about 45 yd. The diver sent down to investigate reported that the force of water issuing from the pipe was too great to allow the latter to be capped, and it was therefore decided to rearrange the unwatering appliances in order to obtain a much greater output than before. Within a few weeks the water level was lowered to about 30 ft. above the shaft bottom, this head being left to oppose the stream from the borehole and facilitate the work of the diver.



To plug the standpipe the arrangement shown in Figs. 1 and 2 was designed, consisting of a tap a into which was screwed a tube b, tapering at its lower end and provided with threads c, intended to cut a thread in the standpipe. The conical portion was continued to a point by means of three pieces of T-section (Section A—B, Fig. 2). A pipe d was secured to the upper end of the tap, to serve as a guide for the winged strap e, in which it could move freely until the strap made contact with a fixed collar on the pipe.

The strap e was connected to the top of the standpipe by means of 1-in. screw bolts g pivoting on a strap mounted on the standpipe, the bolts being long enough (Fig. 2) to allow the tap to be swung. The parts were assembled at bank and taken down by the diver, who, after placing the device in the position shown in Fig. 1, tightened up the strap f on the standpipe and swung the tap through an angle of 90°, thus bringing the point of the apparatus into the mouth of the standpipe and centering the pipe b. On then rotating the whole tap the taper thread cut its way into the standpipe. To prevent the tap being forced out bodily—the water issuing at the rate of nearly 700 gal. per minute, and under a pressure of about 30 atmospheres—the nuts on the rods g were tightened up so as to brace the two straps e and f together, and the tap was then shut (Fig. 2). In this way the sinking and cementing of the shaft could be resumed, after a stoppage of 13 months, although the rock was extensively fissured with small feeders and several large fissures which had to be stopped with many tons of cement.

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*From the Colliery Guardian [illegible]

A similar case arose in sinking a shaft at the Asse potash mine, through bunter sandstone, by the cementation process. On striking a big feeder the tap of the standpipe was turned off, but water escaped through a split in the pipe and flooded the shaft. When the pumps had lowered the water to within about 50 ft. of the shaft bottom a diver was sent down to remove the tap and plug the pipe. The first attempt at plugging, with a couple of steel tubes and rubber washers, failed because the water forced the device out of the pipe, in spite of the free passage left by the tubes. Better results, however, were obtained by the use of a wedge-shaped plug of soft wood which the diver inserted into the standpipe by the aid of a steel pin 10 in. long, stuck in the point of the wedge, the latter then being driven home by a weight attached to the rope, operated from the surface. This plug proved staunch, and the shaft was pumped dry. By forcing cement down the other standpipes, the other holes, including the one substituted for the first named, were plugged as soon as the feeder was reached in boring, and the sinking progressed to completion without further trouble.

**Recovering Grab from Shaft.**—In sinking a shaft on the left bank of the Rhine through tertiary rock, with an iron sinking shaft and Priestman grab, the rope broke at about 30 yd., leaving the grab on the bottom. As the grab excavated mainly at the center, so as to allow the sides to cave and furnish loose soil, the diver sent down had some trouble in locating the grab and clearing away round it so as to allow a strong cable to be attached. The work was rendered particularly arduous on account of low visibility, the water being laden with fine tertiary sand and loam, and quite opaque at the shaft bottom. Almost similar work had recently to be performed in an iron sinking shaft in a mine in Upper Silesia, the sunken grab having first to be dredged clear in between 80 and 90 ft. of water. A heavy cable was attached to the grab, and was lifted by means of a steam winch and pulley tackle alternately, the strain pulling a 2½-in. wrought iron hook (about 3 ft. long) out straight. Eventually the grab was recovered by exerting a gradual pull on the rope.

**Plugging Leaks in Shaft with Concrete.**—In sinking the Adolf shaft of the Eschweiler Company it was found impossible to force the sinking shoe down below about 20 ft. above the coal measures, even after boring out the shaft completely; and on this account a concrete plug was prepared on the shaft bottom and then bored through. In the course of this work several leaks were made, and a diver had been sent down to locate them and plug them with concrete. The expectation that the insertion of a couple of connecting rings would enable the sinking to be carried down to the coal measures without further trouble was not realized, a further leak in the concrete plug necessitating the flooding of the shaft to prevent the caving of the rock. The diver widened the breach to a width of 7 ft., height 1 ft., and depth 20 in., packed sandbags in front of the opening, and quickly kneaded in the cement, poured in with buckets. In a few days the cement had set hard enough to allow the shaft to be unwatered, and sinking was continued to completion.

In putting down a new shaft at the Dutch State Colliery, Emma, the upcast pipe of the shaft pump broke, a length of over 200 yd. of pipe falling down the shaft and burying itself and the sinking pumps in the shaft bottom. A diver was sent down for several days in succession to ascertain the best places for progressively lowering the new sinking pumps, and eventually the shaft was cleared. Another instance of the utility of divers' work was afforded in a pit at Herne, Westphalia, where a shaft was being unwatered by means of water barrels, which operation was retarded by a bar connecting the on-setting device at the pit eye. This bar had to be partly unbolted and partly cut through by the diver, who also repaired and renewed the guides and set up wire netting 10 ft. in height on both sides of the pit eye to prevent the water from floating anything down from the roads into the shaft.

**Installing Centrifugal Pump to Work in 30 Ft. of Water.**—In putting down a new winding rope at the De Wendel pit the old rope, which was attached to the new one, broke and dragged the latter down the shaft, and at the same time completely destroying the tail rope. The whole of them fell into sump and stopped the pump at work there, and the diver was engaged for nearly three weeks in clearing up the damage. Again, while the No. 11 shaft at the Ewald-Fortsetzung pit was in course of sinking, a sudden rush of water flooded the pump motor, and it was decided to install a centrifugal pump to work in 30 ft. of water so that no suction would be required even if the water level were lowered, the motor being mounted just below bank in order to guard against flooding in the future. With this object a diver was sent down to put up a pair of 10½-in. iron girders across the 18-ft. shaft and bolt them to the flanges to the tubbing (Fig. 4). Two iron plates to carry the pump were secured to the girders, the suction pipe of the pump being led up between them. The vertical shaft of the pump was led up about 65 ft., inside the upcast pipe and guided by wooden bearings mounted between the pipe flanges. The upcast pipe was bent horizontally just below the motor and was provided at the bend with a stuffing box for the passage of the pump shaft. The pump was constructed to raise 660 gal. per minute against a head of 190 ft.

In the foregoing operations, wherever compressed air was available, the supply of air to the diver was taken direct from the air mains, thus dispensing with the troublesome work of pumping air. In several cases mine officials who had studied diving operations during their mining school course rendered effective assistance to the diver; and it is therefore recommended that, in the case of pits where water troubles are frequent, some of the officials, overmen in particular, should occasionally practice working in diver's dress (on the same lines as the members of rescue corps exercise with breathing appliances) at some mining school where such instruction is given.

The public utilities of Russia, including canals, railways, water works and gas works, are to be nationalized by decree of the Soviet Council.

# Improved Method of Igniting Fuse

An important method of spitting a round of holes in a drift or stope is described by Mr. E. M. Weston in the Engineering and Mining Journal, from which the following is abstracted:

For many years on the Witwatersrand all fuses were spit by means of a "cheesa stick," which was a thin piece of pine having twisted around it a thin strip of blasting gelatin, sometimes damped with mud to make it burn slowly. The fuse ends were split in the usual manner and the spurting fire from the burning cheesa stick gave a flame that ignited the fuses easily and was difficult to put out even in a wet place. The use of these spitters was finally forbidden by law, and now all fuses are ignited by specially manufactured sticks which give off only a small fraction of 1 per cent nitrous acid gas. Some of these are manufactured by the explosive companies and others under various patents. The improved type gives out a strong flame at the end like that of a slow-burning "squib," is about 6 in. long and ½ in. in diameter, burns for 3 to 5 minutes, and has a wooden handle 3 in. long. Fuses are usually cut 6 ft. in length. It seemed possible to avoid loss of time and labor in igniting each hole in proper succession, and W. J. Pickford has reported as follows upon the system in use at the Crown mines, in the Transvaal, of which he is joint general manager:

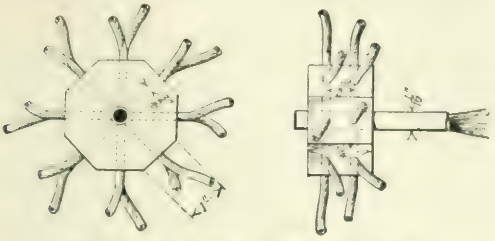
Fig. 1—Igniter Designed for 16-Hole Rounds.

In September, 1916, a trial was made of a fuse igniter designed by Mr. Fisher. This was named the "mouse trap." It proved reliable, and a simple variation is shown in Fig. 1. It is made from a block of soft wood, octagonal in shape, 1¼ in. high with sides of octagon 1 in. long. Through the center of this block a hole 7/16 in. in diameter is made, and each face of the octagon has two 3/16-in. holes with ½-in. centers bored through horizontally to the center hole. A "cape explosive" "cheesa stick" with the glazed paper wrapping taken off the portion in the block is put in the 7/16-in. hole and the pieces with ends cut off square are put into the 3/16-in. holes and pressed up to the "cheesa stick." The pieces are cut for timing beforehand. The miner lights the "cheesa stick" at the other end and has an extra 3 or 4 minutes to get away, or the fuses can be shortened. Miners are so used to coiling the fuses outside the hole to prevent cut-off that they may be prejudiced; but it must be remembered that if the fuse is good and properly cut it should have burnt into the tamping of all holes before the first one goes off.

A small 6-hole block shown in Fig. 2 was tried for stoping. A still simpler form is shown in Fig. 3. The miner cuts his fuses for timing, and, holding the four ends together, inserts them as shown. When blasting, he pushes the end of the "cheesa stick" into the block, and the fuses all ignite together. If less than four holes have to be spit a short length of "dummy" fuse makes up the number to fill the holes. This device has led to the introduction of a blasting gang, comprising a white man and several natives. The miners load the holes in the usual way and prepare the blocks for blasting, leaving a cork on the open end. When the miners come off shift they see the blaster and tell him what holes and benches to blast. The blaster goes down, and, working against the air current and down the stopes, collects the corks as he goes through, counts shots if he can, returns after two hours to blast any misfires, and reports on the air and water service.

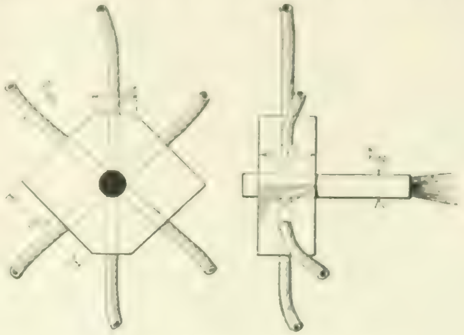
Fig. 2—Plan and Section of 6-Hole Igniter

The system has the following advantages: 1. No one in the section need be exposed to fumes or dust. 2. There is no waiting for the inside man to blast; men can be hoisted regularly. 3. There is no rush in loading holes. 4. There is no danger of natives being in the stope. 5. Trammers and timbermen can work until the end of the shift. 6. There is no confusion in counting holes. 7. The number of "cheesa natives" is reduced. 8. Spitting is quicker and safer. 9. A miner can get out after finishing his work.

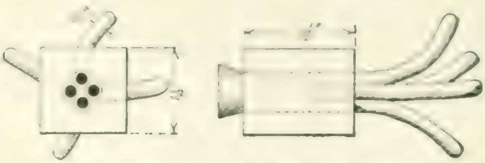
Fig. 3—Arrangement of 4-Hole Fuse Igniter

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**Operation of Lexington Ave. Subway, New York City, Started.**—Temporary operation of the new Lexington Subway of New York City began on July 17. The subway has been in course of construction for several years and will cost completed about $58,800,000, including the equipment, furnished by the Interborough Rapid Transit Co. It represents about 6.25 linear miles of subway, but adds 23.6 miles of track to the new lines of the Dual System in operation.

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**Municipally Owned Electric Railways for Louisiana.**—The State Legislature of Louisiana has passed a bill empowering municipalities in the state to combine and co-operate with each other in the ownership, construction and operation of electric interurban railways and hydro-electric plants. The bill is an exact copy of the act passed by the Mississippi Legislature in March.

# Contractors Appeal to Drainage Districts for Assistance in Uncompleted Portions of Work on Pre-War Contracts

Relief from the present onerous conditions in the drainage field is asked in an appeal to drainage districts by the Levee and Drainage Contractors' Association of the U. S. A. The appeal follows:

Unparalleled and unprecedented conditions confront us. Increased cost of labor and materials and scarcity of such labor and material puts a burden on certain classes of industries which has become almost unbearable. Coal, steel and iron products prior to the war which were most easily obtained, have reached a point where prices are not only prohibitive, but it is almost impossible to obtain them at any cost for certain kinds of industries.

Labor of all kinds is at a premium and a certain floating element that can be hired is not only in some instances woefully inefficient, but will not stay with the job longer than the first pay day.

The drainage contractors, as a class, have suffered from these abnormal conditions more than any other industry. Their work, as a rule, is isolated from the industrial centers and the inducements offered by contractors on Government work, together with heavy draft for military service, have depleted the supply of local labor, which at one time was available.

Prices have been established by the ruling of our Government on all of the principal commodities that are used in this line of work and these prices have been increased from 100 to 200 per cent higher than they were at the time on which the contractors based their figures. In addition by recent rulings of our Government, freight rates were increased 25 per cent.

It therefore becomes necessary for the drainage contractors to appeal for relief. First in the way of an increase in prices on pre-war contracts, or contracts entered into shortly after war was declared, but before the extremely bad conditions existed, or entire suspension of all work that is being done at a loss, due to the chaotic conditions that are entirely attributable to the war, and which were impossible to foresee when contracts were entered into.

Other industries have been allowed to add to the price of their products all these increases, while the contractor is an ultimate consumer and must bear the whole load, for he has nothing to sell to which the increased cost may be added. It is therefore in reason that this appeal is justified and that an increase in the price for work sufficient to absorb this added cost, should be allowed by the taxpayers of drainage districts, when costs were based on pre-war prices. All reclaimed lands have increased substantially in value and all farm products have enormously increased in which the land owner is sharing and receiving benefits.

The Government in many instances with its contractors under similar conditions have added to the price of their work and in other instances allowed the work to be suspended until conditions become more normal. To suspend the work in drainage districts that are partially complete would in some instances be a serious matter on account of the finished portion of the work having no outlet and the lands below being jeopardized by the added overflow that will be caused by the work that is already completed, and the only solution in such cases would be to increase the price to allow the contractors the added cost to them for completing the work.

Another phase of this matter which would lessen the cost, would be that engineers and boards of commissioners, construe the contract and specifications more liberally and not force the contractor to perform unnecessary requirements which add to the cost only and are absolutely of no benefit to the work.

The engineers are therefore requested to make a more liberal inspection and construe the contract more favorably to the contractor. Some engineers have realized the injustice of exacting unnecessary requirements at this time and have voluntarily conceded these points and it should be applied in all cases.

Further the retained percentage which ranges from 10 to 20 per cent on contracts until they are entirely completed, forces the contractor to constantly seek additional funds with which to carry on his work and as the banks have restricted their lines of credit, especially to drainage contractors on account of the dangerous conditions confronting them, renders it almost impossible for contractors to borrow money.

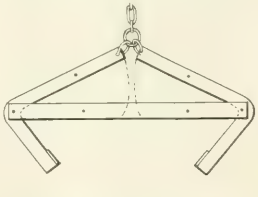
While the retained percentage in some instances is a statutory requirement, it can be offset by allowing advances on material and supplies which must be accumulated far in advance of their needs to enable the contractors to continue the work for reason that no definite date of shipment can possibly be assured by the producers.

We wish to be understood that it is not the desire of the contractor to make any profit on pre-war contracts; all that is desired is an increase sufficient to equal the added cost and we ask that fair and earnest consideration be given this appeal.

In conclusion we wish to state that it is our intention to work in harmony with the various districts so that these pre-war contracts may be completed as speedily as possible, for we feel that it is a patriotic duty to aid the Government in every way possible to drain the lands and enable land-owners to prepare them for cultivation and receive the benefits of their use and that the production of food may be increased to feed our people and our allies in the war.

## Special Tongs for Handling 3 Ft. Sections of Precast Concrete Pipe

Special tongs, devised on the job, facilitated the handling of the precast sections of the filter gallery of Los Angeles, Cal. The gallery consists of 8,000 ft. of 2½ ft. reinforced concrete pipe, the invert portion of which is made up of precast semi-cylindrical sections about 3 ft. long. These sections were cast at points about 350 ft. distant from where they were to be used. The tongs used in handling these sections were attached to the hoisting tackle of a steel traveling crane operating on a portable track alongside the trench. The tongs consist of a steel beam 4 or 5 ft. long having an L-shaped arm pivoted at each end. The short legs were bent at an angle of 90° to the long legs and carried bearing plates to clamp onto the invert sections. When the tongs are open the long legs are bolted to the beams. After the bolts are removed the upward motion of the hoisting tackle revolves around the pivots, causing the lower ends to engage the curved surface of the invert section below the springing line.


Gripping Position of Tongs.

# Railway Construction About to Begin

The long period of dullness in the railroad construction field is apparently about over. A number of good-sized jobs have been placed under contract in the last few days, and many other important lettings are expected in the near future. Schedules of improvements are now being completed as rapidly as possible by the various railways, and contractors will probably be asked shortly to submit figures on a large amount of work. Several of the recent railway contracts have been let on a cost plus a percentage basis. The several hundred million dollars which the Government is to expend during 1918 for improvements, grade revisions and betterments has been apportioned as follows:

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| [illegible] | [illegible],000 |
| Buffalo, Rochester & Pittsburgh | 4,[illegible],000 |
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| Central Vermont | [illegible],000 |
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## Federal Employment Agency to Handle Distribution of Unskilled Labor

After Aug. 1, the recently established United States Employment Service will undertake to be the medium through which employers obtain their unskilled labor. From that date the service will operate its branch offices as labor exchanges for bringing together workers and the employers who need their services. In carrying out this plan the country has been divided into 13 districts, each in charge of a district superintendent. In all 400 branch offices are now being operated or are being opened, and other branch offices will be established as needed.

The centralization of recruitment of unskilled labor will affect establishments employing 100 or more workers. Establishments employing a smaller force will be free, if they choose, to proceed in their usual manner. The establishments which come within the plan, too, will be permitted to hire in the ordinary way such workers as present themselves without inducements from the employer. In other words, employers will be free to engage men who offer themselves at the factory gate without having been solicited, directly or indirectly.

The plan is intended to put an end to the waste and the disorganization which arise from "stealing labor." It is meant to substitute an orderly procedure through which each establishment will be able to supply its needs for unskilled labor in accordance with importance of the work upon which it is engaged. So far as the plan operates to withdraw unskilled labor from industry not directly connected with the war, the withdrawals will be distributed as equitably as possible, under control from the central War Labor Policies Board.

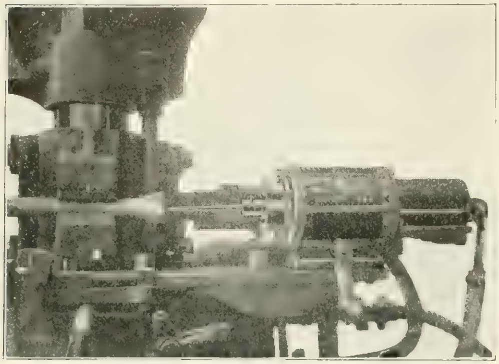
Priorities for labor will be established only where there is an actual shortage. Such priorities as are given will accord with the priorities determined for fuel, materials, etc., by the War Industries Board.

Other principles that have been determined support the general purpose of the plant. For example, the local supply of labor is to be applied to meet the local demand. Workers will be transported from one community to another only when conditions leave no alternative, and then they will be transported the shortest possible distance.

The proposed monopoly of the Employment Service in distributing unskilled labor does not now extend to skilled labor. For the present, skilled labor may be recruited by all employers as heretofore. At the same time, the offices of the Employment Service will in no wise decrease their services in providing skilled workers.

## Pneumatic Punching Device for Drill Steel

A pneumatic device for opening up the hole in the end of a piece of steel while being worked into a bit or lug has recently been placed on the market by the Denver Rock Drill Manufacturing Co., Denver, Colo. This device is called the Model 10 "Waugh Steel Punching Machine" and is designed to be mounted on the pedestal of the company's Model 8 "Waugh" Sharpener directly in the rear of the vise jaws, as shown in the illustration. The punch is held in a tappet chuck and is hammered into the steel as it is fed forward by an air feed cylinder. The operation is very simple and it is stated the punch will open up the water hole in a shank or bit in one-tenth the time required to do it by hand. This device may also be mounted on a separate pedestal where such an arrangement is desirable.



Waugh Drill Steel Puncher.

## Sand Pump Handles Screenings at Crushing Plant

A particularly efficient crushing plant is employed at the Ojus, Fla., quarries of Evert P. Maule. The stone is a coralline formation and unusually hard. It is dredged from under water by two 1½ cu. yd. dredges which load into 6 cu. yd. Western side dump cars. The present cut is over a mile in length and from 20 to 25 ft. deep. At the crushing plant the loaded cars are hauled up a 40-ft. incline railway to the two Champion jaw crushers. The hauling is done by a 3-drum Mundy hoist, which also is utilized for spotting freight cars below the crusher. Each 6-yd. car as it arrives at the top is dumped into a large hopper from which the stone is fed over a grizzly, the fine stuff dropping through, the coarse going into the crusher. As the rock is carried through the crusher heavy jets of water wash out the fine stuff. A steam pump on top of the plant washes out the cars. A 4-in. sand pump takes away the screenings, discharging them into a muck pond from which this fine material is loaded and shipped for various purposes, it having high cement qualities. The average output of the plant is 50 carloads of stone per day.

## News Letter

### St. Louis Items.

Clark & Jackson have resumed work on the M., K. & T. R. R. at Augusta, Mo.

Smith Bros. have subbed the Wood River Levee work near East Alton from Mulvill Bros.

M. L. Windham is building a mine spur and passing track on Illinois Central R. R. near Golconda, Ill.

The Illinois Central R. R. Co. suspended operations temporarily on their new cutoff near Dawson Springs, Ky.

P. J. Murphy has moved a part of his outfit to Moulton, Iowa, where he is building a reservoir for the Wabash R. R.

Cook-O'Brien Construction Co. secured the contract for building a reservoir for the Burlington R. R. near Brookfield, Mo.

The Dunn-McCarthy Co. are doing a lot of force account work for the Pennsylvania R. R. near Terre Haute and Frankfort, Ind.

Newt. Wilcoxon has been appointed an inspector of ordnance and equipment by the government, with headquarters at Knoxville, Tenn.

R. M. Davies finished his work at West Point, Miss. Has a good machine outfit idle. 4533 Chouteau avenue, St. Louis, Mo., will catch him.

Chas. C. Stoner, Mendota, Ill., has 12,000 yards of grading on the Illinois Central R. R. near Peotone, Ill., to sublet. The job is a passing track.

Contractors when in want of labor or work for their outfits write Koenig Labor Agency, 612 Walnut street, St. Louis, Mo., or 503 Delaware street, Kansas City, Mo.

The Old Ben Coal Corporation has about 800,000 yards of grading and a spur and yard at West Frankfort, Ill., to let. R. L. Adams, Christopher, Ill., is chief engineer.

Mulvill Bros. sold quite a number of mules, dump wagons and wheelers to the Standard Oil Co., who are going to use them on their new mine development near Carlinville, Ill.

J. A. Ware has moved his office from the Houser building, where he has been for over twenty years, to 614 Boatmans' Bank building. The Houser building is going to be remodled and used as an annex to the Laclede Hotel.

E. G. Burkham, vice-president of the Moreno-Burkman Construction Co., St. Louis, Mo., has been appointed expert in charge of the commodity section of building materials in the Bureau of Supplies and Accounts in Washington. This is a branch of the purchasing and handling all of building material for the department. Burkham in his capacity as expert in charge of this section will also represent the navy in the building material section of the War Industries Board.

A. B. Koenig.

## Personals

R. S. Parsons has been appointed chief engineer of the Erie R. R.

Thomas H. Reed has resigned as city manager of San Jose, Cal., to return to a professorship at the University of California.

W. B. Storey, formerly chief engineer of the Santa Fe System and later vice-president, has been appointed federal manager of the railway.

Siems-Carey Co., railroad contractors, have opened a branch office in the L O. Smith building, Seattle, Wash. W. F. Carey is in charge of the office.

J. C. Caldwell, manager of the city electric light and water plant of Osceola, Fla., has been elected city manager to succeed J. N. Johnson, who recently resigned his position and left for North Carolina to accept a similar position in Wilmington, N. C.

R. D. Goodrich has resigned as city engineer of Lansing, Mich.. and will sail from San Francisco July 27 for China, where he will be engaged in making surveys, plans and estimates for rebuilding a portion of the grand canal of China, a section about 210 miles in length.

Appointments as follows have been made by L. Kramer, federal manager of the St Louis & San Francisco and Missouri, Kansas & Texas Rys.; B. T. Wood, assistant federal manager of all lines: J. M. Kurn, general manager St. Louis Southwestern; G. N. Whitehead, general manager Missouri, Kansas & Texas; V. K Hendricks, chief engineer of all lines, and G. E. Scott, purchasing agent all lines.

J. G. Sullivan has resigned as chief engineer of the Canadian Pacific Ry. Mr. Sullivan will probably engage in private practice, but he will also retain his connection with the railway company in a consulting capacity. For the present it is his intention to take a rest on account of slight impairment of his health due to the strain of his heavy duties, more particularly the construction of the Connaugh tunnel through the Selkirk mountains.

The Emergency Fleet Corporation has announced the creation of the office of district manager in the efforts being made to speed up production. Sidney G. Jenks was appointed to supervise construction in District No. 3, embracing all plants south of Wilmington, Del., and including the coast of Virginia. Henry Penton will assume control of District No. 9, comprising the Great Lakes zone, and A. F. Pillsbury will be in charge of District No. 7, embracing California.

The following promotions have been announced for the Pennsylvania Lines West: R. D. McKeon, division engineer, western division, vice Guy Scott, furloughed for military service; T. C. Herbert, assistant division engineer, Pittsburgh division, vice McKeon; F. N. Hawthorne, assistant division engineer, St. Louis division, vice Herbert; T. H. Miller, assistant division engineer, Louisville division, vice Hawthorne; I. A. Jaques, assistant division engineer, Zanesville division, vice G. U. Middleton, deceased; W. R. Triem, assistant division engineer, Akron division, vice Jaques.

W. A. James has been appointed assistant chief engineer of the Canadian Pacific Ry. Mr. James has been construction engineer of the company for a number of years. He was first in charge of the grade revision work done on the line between Moose Jaw and Swift Current and between Swift Current and Medicine Hat. Subsequently he was in charge of the donbletracking of the line between Fort William and Winnipeg and later built thousands of miles of line for the company throughout Western Canada, and also conducted the doubletracking operations west of Winnipeg.

*Building and Structural*
*Monthly Issue*

# ENGINEERING *AND* CONTRACTING

HALBERT P. GILLETTE, *President and Editor.* LEWIS S. LOUER, *Vice President and General Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $[illegible].00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering field. See advertising page for further information and subscription coupon.

**Roads and Streets—1st Wednesday**
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies

**Waterworks and Hydraulics—2nd Wednesday**
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power

**Railways and Govt. Works—3rd Wednesday**
(a) Excavation and Dredging (c) Harbors and Docks
(b) Rivers and Canals (d) Railway Construction

**Buildings and Structures—4th Wednesday**
(a) Buildings (c) [illegible]
(b) Bridges (d) Miscellaneous Structures

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## Are Engineers Narrow Minded? If So, What Class Is Broad Minded?

Not long ago "The Canadian Engineer" quoted at length from an article by Charles M. Horton in "Industrial Management," and condemned Mr. Horton's statement that engineers are narrow minded. Mr. Horton said in part:

> Something is wrong with the profession—has been wrong from the first. Engineering courses are not quite what they should be—not quite complete. If they were, engineers would be different. They would think in channels somewhat broader than they do; they would see with clearer and more generous vision. Engineers must think in broader channels—must see with more generous vision—if, having once moved into the forefront, as they will, they would remain there—would not go back—as the clergy has gone back, as the law has gone back, as medicine is going back. Once to the front, engineers could stay there. They could stay there if only they would profit by the mistakes of their brethren in the older professions, and study the New Management. Which means that engineers have got to forget some things and learn some other things. Forgetting, and learning, they will have attained to mastery over the world. . . .
>
> The human element, after all, despite mechanical perfection, despite the laws governing the sum of two figures, is the vital element, the element that makes or breaks—the one science above all sciences deserving of consideration and study on the part of the engineering fraternity.
>
> Engineers as a race have not studied it. They have considered it, of course, as in the designing of apparatus; but this consideration for the most part may be summed up and dismissed—as it is summed up and dismissed in all drawing-rooms in a single compound word, "fool-proof."
>
> Out of all this emerges a broad general conviction. It is that the engineering mind, taken collectively, is a narrow mind. If it is a narrow mind—and, personally, I believe it is—it is so by reason of the specialized intensive training given engineers in preparation to pursue their profession. Of all the students in any university, "engineers" are seen least on the campus, least in the gymnasium, least on the track and field. They haven't the time. It would be better for the profession if this were otherwise. Campus and gymnasium are places where the human side is brought out, and it is the human side that is lacking in development in the average engineer. Anything that would tend to develop this in the man would likewise tend to develop it in his profession. [illegible] of the foibles of humanity would broaden and soften.

"The Canadian Engineer" does not agree with Mr. Horton's premises, consequently it cannot concur in his conclusions, nor can we. That many engineers are relatively "narrow minded" is undeniable, but that, as a class (engineers are not yet a "race," Mr. Horton), they are more narrow minded than other classes of men we deny. Are engineers usually less well versed in practical psychology than lawyers? Doubtless, but consider, on the other hand, how poorly versed in economics most lawyers are. Are engineers prone to give less thought to men than to structures and machines? Doubtless that is true also, but consider the opposite tendency in bankers and railway officials, if you would realize how narrow minded they can be.

An American chemist told the writer, prior to the war, that he despaired of seeing America become as great a manufacturer of chemicals and chemical products as Germany. His despair arose not because we lacked well-trained chemists, but because we lacked financiers and business men whose knowledge of chemistry was enough to enable them to have the necessary imagination about a chemical project to back it with their dollars. And that chemist was right. A mechanical engineer can go to almost any business man with drawings of a new machine, and he can make the business man understand enough of it to arouse his imagination both as to its physical and its commercial possibilities. But let a chemical engineer go to the same business man with his chemical formulas and calculations, and he might as well talk to a Hottentot about the mechanism of an internal combustion engine or Kepler's laws.

Every specialist, if he is highly successful, must be "narrow minded" to some extent. We engineers necessarily cannot know equally well all about (1) practical psychology, (2) financiering, (3) accounting, (4) engineering economics, (5) applied science and (6) mathematics. If the business man and the financier know the first three of these subjects better than most engineers know them, remember that all engineers know the last three subjects better than any other men know them. Also remember that it was not the business men who developed a "Science of Management," but that it was a group of engineers, and that in doing so they proved themselves superior as practical psychologists.

We do not deny, of course, that engineers should aim to broaden themselves constantly, and, in fact, a very large percentage of engineers have always striven to widen their range of knowledge and their view of human affairs. But such a statement is a long shout away from Mr. Horton's assertion that "Something is wrong with the profession," and that "the engineering mind—taken collectively—is a narrow mind." Judged by what engineers are accomplishing in numberless fields of human activity, they are among the "broadest" of the inhabitants of this "narrow minded" world. What man dares call himself really "broad minded" in the sense that he has even peeped into every compartment of human knowledge? None but a very narrow minded man could have ignorance to assert that any living mortal is truly broad minded.

## Architects Must Realize That Structural Engineers Are Their Professional Equals

An editorial entitled "Why Engineers Rather Than Architects Are in Charge of Government Building Work" appeared in our Building and Structural Monthly issue of Apr. 24. The editorial has been quoted by several architectural magazines. In no instance has it been denied that our statements were correct. "Architecture and Building" calls upon architects to awake and adapt themselves to modern conditions. It says of the architect:

> With lofty thoughts and stilted ethics, he has strode along without an appreciation of the progress about him, ever changing, searching, specializing. Business—life—is a continuous revolution. New precepts rule to be superseded by even other newer precepts. The professional practice of architecture has not kept pace and is therefore doomed. It must be reborn from the ashes of the past, even as the legendary phoenix

Contrasted with this purely professional attitude of aloofness from business and economic affairs, "Architecture and Building" points to the engineer thus:

> It was the trained engineers of the country who became the technical advisers of the Government on planning, design, and construction, utilization of existing facilities to the utmost, expansion of them and creation of new utilities. It was our trained engineers already well organized in our great building construction firms into harmonious working units, companies, even regiments, who were ready in the hour of need to do the deed.
>
> Professionally as such our architects have not been a factor in the greatest building emergency the country ever saw. Individually, to many the greatest praise is due. They have donned the uniform, striven at home and fought abroad and given of their best in ability, effort and resourcefulness. But as a profession in the oft vaunted position of autocrats of the building industry they have been wanting. And the reason is not beyond discernment; it is an inheritance from the past; architectural practice has not kept pace with the times.
>
> The need of federation in the building industry as a war time need has been met. Why not face the truth squarely and hold a conference to reorganize the out worn system of professional practice?
>
> The after-war period in the building industry will be a time of great enterprise and expansion. In this the architect should play a prominent part, but his days of autocracy are over and his success will depend on his ability to co-operate, not to dictate. Now when the architect secures a job he calls on the foundation builder to figure his footings, he depends on the steel contractor to design the structural members, he depends on the plumbing contractor to draw up his plumbing layout, he expects the electrical contractor—but why go on?—and when the building is finished he zealously, often belligerently, demands exclusive credit for its entire design and construction.
>
> The day for this is past—and why? The architect has been losing business. Others who build better, more efficiently and more economically under the name of architectural or engineering contracting firms have taken the work from him, and they work on the principle of co-operation, not autocracy.

"Architecture and Building" has courageously stated the facts. It is indeed a bitter pill for the architectural profession to swallow, but the profession can be purged of its autocratic attitude in no other way. Structural engineers have been regarded by most architects as a necessary evil, and have usually been denied the privilege of becoming members of architectural firms. Indeed, the "professional ethics" of architects has been such as to aim at the exclusion of structural engineers from the legal right to design buildings at all, save under the guidance of architects. Witness the architects' license laws in many states. The inevitable has now happened. Because architects would not treat structural engineers as equals, structural engineers resolved to force themselves into a pre-eminent position in spite of architects. The war gave structural engineers their great chance. How well they availed themselves of their opportunity all engineers know, and architects are now beginning to concede.

There is, of course, room for both architects and structural engineers, and a need for both. The engineer as the economist and the architect as the artist should work together in harmony and as equals, each in his realm. The day is past when the architect can safely take all the glory for a building that was mainly designed by structural engineers. Let him assume the credit for the artistry shown in its design, but for the economics in the design let him give full credit to the engineer. Those architects who cannot thus cooperate with engineers are doomed to extinction, for in this era of specialization no one man can know all or even pose as being all.

## Why the Government Should Increase the Output of Wooden Ships

Prior to the war a wooden vessel of more than 3,500 tons was a rarity. There was launched in April by the Southern Shipbuilding Co., Orange, Tex., a 4,700-ton wooden boat of the Daugherty type. It has been recently announced that the structural engineers of the Shipping Board have designed a 5,000-ton vessel along the lines of the Daugherty model, and that these 5,000-ton ships will soon be turned out in quantities.

In commenting upon this 4,700-ton boat in our issue of Apr. 24 we said:

> It will be remembered that Gen. Goethals opposed the building of many wooden ships, but his adverse decision has been questioned by many men. * * * * It is our belief that Government officials on the Shipbuilding Board will do well to review the entire question of building wooden ships. Let the structural engineers who have designed wooden ships be given a careful hearing. * * * Like any other economic problem, this is one not to be solved by opinions unsupported by reliable data.

It is evident that the Shipping Board has reviewed the question of building wooden ships and has decided not only to build them in large numbers but in larger sizes than have hitherto been considered practicable.

In our issue of Apr. 24 we gave a list of 63 companies that had government contracts for 490 wooden ships, and the prices therefor. With few exceptions they were all 3,500-ton vessels, and the price averaged about $80 a ton, exclusive of machinery. The machinery costs about $70 more per ton of vessel of this type. In the same issue the names were given of 30 companies having contracts for 720 steel vessels, the average price of which was about $160 per ton, exclusive of machinery. The Shipping Board has been reported as stating that the cost of hulls of steel ships is about $175, and of concrete ships $125 per ton.

Since wooden hulls are being built by contract for as low as $70 a ton, and at an average of about [illegible] a ton, and in view of the scarcity of steel, it would seem the part of wisdom greatly to increase the production of wooden ships.

The old argument against wooden ships on the score of limited size is gone. The argument that their life is very short is not borne out by data. The claim that there are not enough ship carpenters and calkers is negatived by the fact that men for wooden ship construction can be trained very rapidly, even more rapidly than steel workmen are trained. And, finally, the arguments that timber cannot be secured in sufficient quantity and of adequate sizes, have already been shown to be false. Structural engineers, by designing a new type of wooden ship (the Daugherty type, described in our issue of Mar. 27), have proved at one stroke both that small-sized timbers can be used and that wooden vessels of 5,000 tons or more in size can be built.

Schwab is too broad a man to be influenced against the building of wooden vessels because his own specialty is steel and steel work. Therefore if the structural engineers who have already solved the problem of designing large wooden ships are backed by evidence that the lumber producers can deliver the timber rapidly enough, there is little doubt that we shall witness an enormous output of wooden ships during the coming year.

## How Certain Subscribers Determine Relative Worth of Different Engineering Periodicals

Perhaps the best single test of the worth of the articles published by an engineering periodical would be the number of them that you would clip out for your files were it your practice to clip all worth-while articles. A good many engineers do this very thing, and they are usually the best judges of the relative value of different periodicals. One of our readers recently wrote us as follows:

> I have been a 'sub' to Engineering and Contracting for several years now and I want to say that the clippings that I have saved from about five different journals carry about 40 per cent from your valuable weeklies. I get more real good out of them than from any other periodicals that I have and am always glad to see them here.

That nearly half of all articles clipped from five engineering journals by this reader were taken from Engineering and Contracting during the last few years is evidence to that reader of the real merit of "E. and C." It is, moreover, real evidence and is not his "impression." It is a scientific method of arriving at a conclusion—an engineering method of judging.

The tendency of many engineering readers is to be unduly impressed by mere bulk of reading matter and by pictures. The bulk may be mostly unusable, like the bloated pages of a Sunday newspaper, and the pictures may seldom tell more than the text itself tells, but the unanalytical reader is impressed by the appearance of worth and does not put the appearance to a real test.

Fortunately a very large number of engineers and contractors are discriminating, and they are so because they are students of their professional and business problems. To such and only to such men has Engineering and Contracting been addressing itself for exactly 12½ years. The result is that, while our "family of readers" is not yet the largest, it comprises the most discriminating and therefore the most progressive men in the civil engineering field.

## Engineering Students Should Be Exempted From Draft

In this issue we publish two convincing appeals to the Government to take action that will increase the number of engineering students. Prof. C. R. Richards and Prof. M. E. Cooley thus act as spokesmen for us all.

Prof. Richards goes so far as to advise the drafting of enough high school graduates to fill the engineering colleges. Why not? Since the Government has been so short-sighted as to permit engineering students to enlist, some radical steps must now be taken to fill the depleted classes in technical schools. If the Government does not care to take the radical step proposed by Prof. Richards, the least it can do is to give wide and persisting publicity to the fact that young men should enter our engineering colleges this fall in greater numbers than ever before. Moreover, the Government should exempt from draft every engineering student who is able to pass the college examinations. The present rule that only those standing in the "upper third of the class" are to be exempted is inadequate and should be revised as soon as possible.

## Concrete Delivered by Compressed Air Into A Retaining Wall.

The use of compressed air for transporting concrete for tunnel lining has ceased to attract attention because of its novelty. Now the air conveying process is being applied to other classes of concrete work. For example, P. J. Joyce & Co., of New York, contractors for the masonry work involved in the B. & O. grade separation project at Pittsburgh, have used the air method in building concrete retaining walls. A central plant was used to mix and force the concrete a maximum distance of 1,500 ft. through and 8-in. pipe, using air at 80 to 100 lb. pressure. The concrete was first shot into a receiving hopper, carried on a traveler that straddled the wall, and thence was delivered by gravity through a flexible pipe into the Blaw steel forms which were also carried by the traveler. A locomotive crane was used to roll the traveler along a track.

**Industrial Uses of Paving Brick.**—Vitrified paving brick, although made primarily for street and road work, are used to a considerable extent about industrial plants, where floors and drives capable of withstanding hard service are required. At the plant of the Willard Storage Battery Co. of Cleveland the floors are paved with vitrified paving brick. Four-ton loads are frequently carried over these floors on small electric trucks. This company also has used paving brick in building tanks for acid baths. The entire plant of the Artificial Silk Co. was built of paving brick.

**Floor Forms Supported on Trench Jacks.**—Trench jacks were used to carry the supports for the floor forms for a concrete shop building erected recently at Chicago. It was possible with these jacks to make easily the necessary adjustment of level. This precaution was taken because of uncertain ground conditions.

# Design and Construction Features of Concrete Viaduct Approach to Central Ave. Bridge, Kansas City, Kan.

An excellent example of simple artistic concrete design is afforded by the east viaduct approach to the new Central Ave. bridge at Kansas City, Kan. In this design the engineers, Harrington, Howard & Ash of Kansas City, Mo., have tried to work out a viaduct which would be essentially a concrete structure, simple of design, and not a structure built of concrete in imitation of well-established details for forms of structures built of stone or of other materials. There were no funds for adornment, and the section of the city in which the viaduct is located, in its present and probable future condition, would not warrant such adornment. The structure is in the vicinity of the stock yards serum plants and packing plants and railroad yards, industries which are likely to be enlarged and take in adjacent property now devoted to the homes of the workmen.

The structure is intended to look as if it was built of a once plastic material, monolithic and continuous, and not made up of separate units or blocks or stones. The lines of the longitudinal girders and of cross girders are carried down the columns so that the columns might appear, as they are, actual parts of, or continuations of, the girders and beams. There is no horizontal line breaking the column from its base at the ground surface clear up to the top. All of the extruding corners are rounded, following the filleting usual in the molds for any poured material. The concrete is without any special surface finish, but was left in its condition when the forms were taken down.

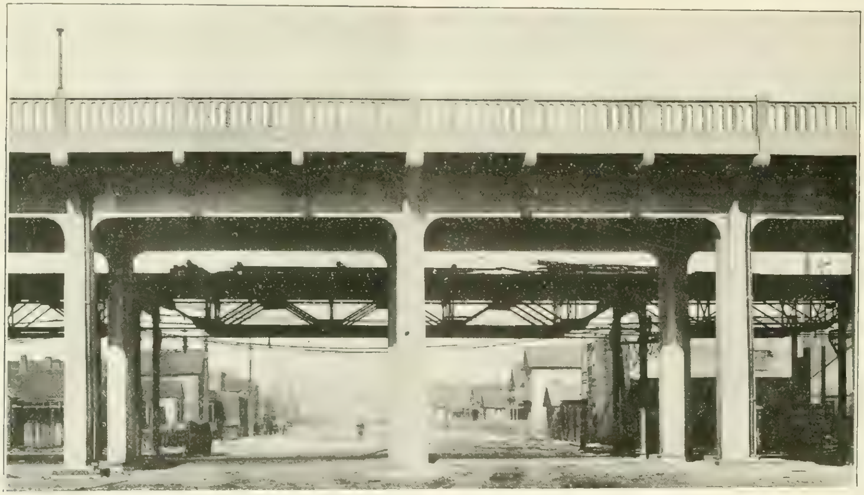
The design is an attempt, therefore, to produce in a modest way a structure pleasing in appearance, obviously suited in design for the material of which it is constructed, without slavish imitation of architectural forms primarily designed for other materials.

The east approach viaduct has a total length of 1,680 ft., made up of spans of a normal length of 40 ft. The columns are 30x36 in. to 36x36 in.; main girder, 24 in. x 5½ ft.; panel length, 10 ft.; floor slab, 9 in.

The pedestals are supported on Raymond concrete piles having a penetration generally of about 20 ft. below bottom of pedestal. The piles were driven by the Raymond Concrete Pile Co. with one of its standard rigs. Except near the river, the material through which the piles were driven was a rather fine sand. It was provided in the specifications that piles should be of lengths sufficient to carry the imposed loads, but in no case less than 16 ft. long. The Engineering News formula was considered to indicate the safe load which could be supported by a pile, and with the weight of hammer and height of drop used a final penetration of 1 in. for four blows was required to give the safe imposed load of 30 tons. In general, however, the final penetration was six blows per inch, and in a good many cases as high as ten or twelve was required to get the required total penetration.

After the pedestals were concreted the column reinforcement was put in place and wired securely to the dowels projecting from the pedestal. This reinforcement consists of 12 vertical bars and two sets of tie bars each spaced 15 diameters of the bar. A light movable scaffold was used for erection of column steel. In order to allow adjustment of the reinforcement to fit accurately within the forms the two sets of tie bars were wired to each other only at the top, which could readily be reached after forms were in place. After the column steel was in place the column forms were erected. They were of 2-in. tongue and groove timber and were same as would be used for a square column with the addition of a beveled box in each corner to give the cross shape of a column.

Forms were fabricated in two halves so that they could readily be placed around column steel. The column forms extended up to the beginning of curve, the curved portion of form being a part of beam forms. As the construction of the viaduct was begun at the lower end, it was necessary to provide new forms for each column, which made the form cost rather expensive.


Reinforced Concrete Viaduct Approach to Central Avenue Bridge, Kansas City, Kan.

The cantilever beam bottom and curved end portions of girders were carefully cut out and put together in the form shop, which was located near the end of the viaduct, and were then set in place on top of the column forms, which had been cut off the exact length before being erected. The balance of the forms were constructed in the field and were of ordinary construction. The forms were supported on posts resting on mudsills, a post being used at the end of each cantilever beam and others as required along the cross girders and longitudinal girders. The plank for floor slabs was supported on longitudinal joints which rested on vertical studs on the sides of the beams. These studs were independent of the verticals on beam forms so that slab forms could be removed without disturbing the beam forms. To prevent a sag due to settlement, with consequent bad appearance in girders and cross girders, the centers of these forms were raised ½ in. above the required elevations; the results were very satisfactory.

To give the rounded corners on columns, girders and beams, a cove molding was placed in the forms. This had a radius of 2 in. and was cut out of 1-in. stuff, being therefore rather thin and difficult to handle. To prevent bad warping it was necessary to use an unusual number of nails to hold it in place. It was difficult to place this molding properly around the short curves at ends of cantilever beams and around the curves at ends of girders and cross girders. By cutting the back and side of the molding every few inches the carpenters soon became very expert and produced a very satisfactory job.

With the exception of the girder reinforcement, all reinforcement was assembled in place. The steel for first few girders was also assembled in place, but as the girders were long and narrow this was slow and difficult. The expedient was then tried of assembling girder reinforcement complete immediately above the girder forms and then lowering it into place, and this proved very satisfactory. The reinforcement was thus assembled complete for three or four spans for the total distance between expansion joints, being supported as joists spanning the girder form.

Usually the entire structure between successive expansion joints (three or four spans) was concreted continuously. This does not include the columns which were filled up to the beginning of curve at top of column on the day preceding the general concreting. A tower was used for pouring all concrete.

The average quantities and cost per linear foot of the concrete viaduct of the east approach, which has a 30-ft. roadway and 6-ft. sidewalk, were as follows:

| | Per lin. ft. |
|---|---|
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| Raymond concrete piles, 8.75 lin. ft. at $1.35............ | 11.81 |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| | $78.61 |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| Total cost per linear foot............................ | $83.53 |

**25 Per Cent Saving of Steel in Concrete Piles by Change in Design.**—By changes in the design of their concrete piles the California State Board of Harbor Commissioners has reduced the steel requirements so that the amount now used in 95-ft. piles is the same as that used 6 years ago in 66-ft. piles. In their latest design of 100-ft. pile, by changing from a 4-point to a 5-point pickup, leaving out reinforcement where it would not carry stress, they have effected a 25 per cent saving of steel.

# The Basic Principle of Concrete Mixes and the Truly Fundamental Role Played by Water*

By DUFF A. ABRAMS,

[illegible]

It is commonly stated that concrete is composed of a mixture of cement, sand and pebbles or crushed stones. This conception of concrete overlooks one essential element of the mixture, namely water. An exact statement of the ingredients of concrete would be: Cement, aggregate, and water. The last-named material has not yet received proper consideration in tests of concrete or in specifications for concrete work.

Early users of concrete centered their entire attention on the quality of the cement and practically disregarded the characteristics of the other ingredients. During the past dozen years some attention has been given to the importance of the aggregate, but it is only recently that we have learned that the water also requires consideration.

A great deal has been said and written recently concerning the effect of water on the strength and other properties of concrete, but the full significance of this ingredient of concrete has not heretofore been pointed out. A discussion which appeared in the April, 1917, issue of the Concrete Highway Magazine gave a brief review of results of some of the experimental work carried out along this line at the Structural Materials Research Laboratory, Lewis Institute, Chicago. The relation between the water content and the compressive strength of the concrete for a wide range of consistencies was there pointed out and emphasis was placed on the injurious effect of too much water.

Tests made in studies of the effect of size and grading of aggregates have shown that the only reason that concrete of higher strength and durability can be produced from well-graded aggregate as compared with a poorly-graded aggregate is that the former can be mixed with less water. If this is not done no advantage is gained from using a coarse, well graded aggregate. The following discussion shows that a similar conclusion can now be stated with reference to a rich concrete mix as compared with a lean one:

While the injurious effects of too much water in concrete are apparent, tests made in this laboratory show that the truly fundamental role played by water in concrete mixtures has been entirely overlooked in previous discussions of this subject. The relation referred to above is brought out by a series of compressive tests of about 1,600 6 by 12-in. concrete cylinders made up as follows:

| Mix | [illegible] | Consistency |
|---|---|---|
| [illegible] | [illegible] | [illegible] |
| 1 — 9 | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| 1 — 3 | Sieve | [illegible] |
| [illegible] | [illegible] | [illegible] |
| 1 — 1 | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |

The mixes used covered a wide range, as did also the grading of aggregate and consistency. The aggregates consisted of two sizes of sand and mixtures of sand and pebbles graded to the sizes shown. The mix is expressed in terms of volumes of dry cement and aggregate, regardless of grading; i. e., a 1:5 mix is made up of 1 cu. ft. cement (1 sack) and 5 cu. ft.

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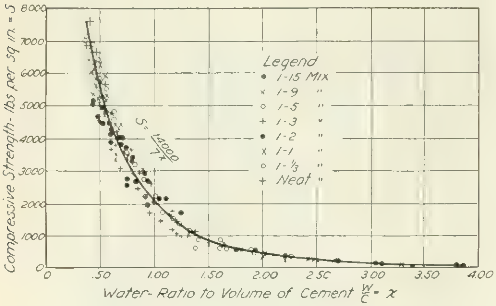
*[illegible] Highway [illegible]

of aggregate as used, whether a sand or a coarse concrete mixture.

This series gives valuable information on the effect of changing the quantity of cement, the size of the aggregate and the quantity of water. The effect of many different combinations of these variables can be studied. One set of relations gives the effect of amount of cement using aggregates of different size and grading; another set of relations gives the effect of different quantities of water, varying both mix and size of aggregate, etc. In all respects these tests bear out the indications of both earlier and later series. These tests are of interest in that they reveal for the first time the true relation between the strength and the proportions of the constituent materials in concrete.

The figure shows the relation between the compressive strength and the water content for the 28-day tests. The water content of the concrete has been expressed as a ratio of the volume of cement, considering that the cement weighs 94 lb. per cubic foot. Distinguishing marks are used for each mix, but no distinction is made between aggregates of different size or different consistencies.

When the compressive strength is platted against the water in this way, a smooth curve is obtained, due to the overlapping of the points for different mixes. Values from dry concretes have been omitted. If these were used we should obtain a series of curves dropping downward and to the left from the curve shown. It is seen at once that the size and grading of the aggregate and the quantity of cement are no longer of any importance except in so far as these factors influence the quantity of water required to produce a workable mix. This gives us an entirely new conception of the function of the constituent materials entering into a concrete mix and is the most basic principle which has been discovered in our studies of concrete.



Relation Between Compressive Strength and Water Content.

The equation of the curve is of the form,

$$S = \frac{A}{B^x} \dots\dots\dots (1)$$

where S is the compressive strength of concrete and x is the ratio of the volume of water to the volume of cement in the batch. A and B are constants whose values depend on the quality of the cement used, the age of the concrete, curing conditions, etc.

This equation expresses the law of strength of concrete so far as the proportions of materials are concerned. It is seen that for given concrete materials the strength depends on only one factor—the ratio of water to cement. Equations which have been proposed for this purpose contain terms which take into account such factors as quantity of cement, proportions of fine and coarse aggregate, voids in aggregate, etc., but they have uniformly omitted the only item which is of any importance; that is, the water.

For the conditions of these tests, equation (1) becomes,

$$S = \frac{14000}{7^x} \dots\dots\dots (2)$$

The relation given above holds so long as the concrete is not too dry for maximum strength and the aggregate not too coarse for a given quantity of cement; in other words, so long as we have a workable mix.

Other tests made in this laboratory have shown that the character of the aggregate makes little difference so long as it is clean and not structurally deficient. The absorption of the aggregate must be taken into account if comparison is being made of different aggregates.

In certain instances a 1-9 mix is as strong as a 1-2 mix, depending only on the water content. The strength of the concrete responds to changes in water, regardless of the reason for these changes.

It should not be concluded that these tests indicate that lean mixes can be substituted for richer ones without limit. We are always limited by the necessity of using sufficient water to secure a workable mix. So in the case of the grading of aggregates. The workability of the mix will in all cases dictate the minimum quantity of water that can be used. The importance of the workability factor in concrete is therefore brought out in its true relation.

The reason a rich mix gives higher strength than a lean one is that a workable concrete can be produced by a quantity of water which gives a lower ratio of water to cement. If an excess of water is used we are simply wasting cement. Rich mixes and coarse, well-graded aggregates, are as necessary as ever, but we now know just how these factors affect the strength of the concrete.

Practical use may be made of the curve in estimating the relative strength of concrete in which the water content is different for any reason. For example, a concrete mixed with 7.5 gal. of water (1 cu. ft.) to one sack of cement (allowance being made for absorption of aggregate) gave a strength in this series of 2,000 lb. per square inch ($x = 1.00$). For $x = 0.80$ (6 gal. of water per sack of cement) we have 3,000 lb. per square inch; for $x = 0.75$ (5.6 gal.), 3,300 lb. per square inch. Concrete in a 1-4 mix (same as the usual 1-2-3 mix with a coarse sand) should be mixed with 5½ to 6 gal. of water per sack of cement.

The importance of any method of mixing, handling, placing and finishing concrete which will enable the work to be done with a minimum of water is at once apparent. It now seems that practically all faulty concrete work can be traced to the use of too much water.

These studies lead to many important conclusions with reference to such topics as tests of cement, tests of concrete, containing admixtures, etc. Tests of cement from this viewpoint have been under way for several weeks.

Laboratory research performs its true function when it uncovers basic principles which have not been revealed by experience in construction, or observation of completed work.

# Heat and Heat Transmission*

By PROF. JOHN R. ALLEN.

**Constants for Heat Transmission.** For years we guessed at heat losses from buildings by some rule-of-thumb. These rules were usually proposed by someone supposed to know more about heat than anyone else and were usually very dangerous to apply throughout a wide range of conditions.

We have followed the German, the theory of which is generally considered to be at least approximately correct, but these formulas require certain practical constants for heat transmission. The heat laboratory at Charlottenburg has determined many of these constants for German forms of building construction, but very little work has been done in this country. Some years ago I started to check up the German constant for glass, which of course is the most fundamental constant that we have. I found that for dry glass with no rain or wind the constant $K = 0.64$; for rain and no wind, $K = 1.248$; for wind and no rain, $K = 1.05$; for rain and wind, $K = 1.485$. The generally accepted constant by authors as determined by the German government is 1.3 and for 15 years we have accepted this constant. It is entirely possible to have the glass surface wet even in zero weather and the constant is manifestly too small. Personally I am now using $K = 1.25$ as the glass constant. This only goes to show that some of our fundamental facts are wrong and need a careful checking up.

When it comes to the constant K for cement, hollow tile, metal lath and similar construction, practically all the constants we have are based upon computation—they are only approximate. They may be right; they are probably wrong or largely in error, and we have no experimental work to guide us. We need in this country a vast amount of experimental research so as place these fundamental constants of the heating business on a well-established foundation.

**Heat Losses from Infiltration.**—One of the important factors in determining the heat loss from a building is the amount of air that leaks in around the cracks and crevices. One of the first assumptions with respect to infiltration was made by Carpenter, in which he assumed that the air in a room was changed once per hour due to infusion of air from outside or infiltration. In the average room this is approximately true. On the other hand, there is absolutely no reason why the cubic contents should have anything to do with infiltration, as infiltration occurs largely around the windows and window frames, and it should be based on wall and window conditions and not upon cubic contents. Recent experiments in New York show that, particularly in metal sash, infiltration should be based upon the perimeter of the sash.

Of course, there is no one factor in this that we will never know, as no one can foresee how tight or how loose the contractor is going to construct the building. Such phases of our computations will always have to be covered by adding a certain percentage which might well be called the "factor of ignorance."

**Radiation and Radiators.**—We have much more explicit information in regard to radiation than in regard to heat loss from buildings. We know that a two-column 38-in. radiator will give a value of K of about 1.65 B. T. U. with 1 lb. steam pressure and a room temperature of 70°. We know that this constant K increases as the difference between the temperature outside the radiator and the temperature inside the radiator increases. The approximate formula is:

$$K = 1.445 + 0.001427 (T_1 - T_2)$$

where $T_1$ = the temperature of the steam and $T_2$ = the temperature of the room.

We know something about the painting of radiators. If a radiator is painted with any kind of flake metal pigment, such as aluminum, gold or bronze, its efficiency is reduced approximately 25 per cent. If it is painted right over the aluminum with an enamel, the heat transmission is the same as the bare iron. I have made these experiments with 14 coats of paint on the radiator and the effect of the last coat was practically the same as that of the first coat.

This shows that the heat transmission of the radiator depends upon the ability of the surface to dispose of the heat and not upon the conductivity of the material of which the radiator is composed. That is, under the conditions existing in a radiator, the heat is transmitted much more rapidly through the metal of the radiator than the surface of the radiator can dissipate the heat. It is possible that we may find some coating which can be placed upon a radiator that will increase its conductivity beyond that of the bare iron. I do not know that any attempts have ever been made to do this, but it is one possible means of increasing radiator efficiency.

A radiator gives off heat in two ways—by radiation and by convection. For many years I have tried to find out what proportion of the heat is given off by radiation and what proportion by convection. Approximately it is "50-50," but I have never been able to make a satisfactory determination. This is impossible, as undoubtedly some of the radiant heat from the radiator passes directly out through the wall and window surface without having any effect, and we may find it desirable to so arrange our radiators that all heat given off by them is given off by convection. We should have more fundamental knowledge on this subject.

Take the indirect radiation, and by indirect radiation I mean that not only through which air circulates by natural circulation, but through which air circulates by means of a fan or of fan coils. We know that in this type of radiator all the heat from the radiator is given off by convection, and in convection the form of the surface plays a very important part in its effectiveness. We also know, and recent experiments prove, that effectiveness of its surface is practically independent of the material of which the surface is composed. Copper, cast iron and wrought iron give practically the same effect.

The condensation from surfaces of this kind depends upon the air resistance of the radiator, provided the radiator is properly designed. That all depends upon the temperature of the surface and the temperature of the air. Since the condensation depends upon the air resistance of the radiator, in radiators of this class low resistance is not wanted because, in order to get the condensation, it will be necessary to put in a number of radiators. Some engineers have specified widely spaced fan coils of low resistance and then put in a bank of coils in order to obtain condensation. This is simply wasting surface, as the same heating effect could be produced with closely spaced coils and a much smaller number of them.

**Determining Pipe Sizes.**—In this country we probably give less consideration to pipe sizes than in any other engineering country. The sins committed by the average contractor in the matter of pipe sizes are legion. When we get down to the economical use of pipe there is just one way to determine the sizes, and that is to determine the resistance of each piece of pipe. We design good fan-piping systems for air by resistence, and yet we design our steam-piping sizes on a heating job by guesswork and experience—these terms are sometimes synonymous.

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*From a paper presented at the [illegible] American Society of Heating and Ventilating Engineers.

Some years ago, when I had some time on my hands and a heating plant was to be designed, I designed a real piping job and figured the pipe resistance to each radiator, and it is the most satisfactory job of heating that I ever installed. The average engineer, however, is too lazy to go to the trouble of doing this, and I am just as guilty as the rest.

To take pipe sizes out of a table and have them determined by the square feet of radiation is no basis of reason on a large job. It is quite possible that close to the boiler you can put 150 sq. ft. of radiation on a 1¼-in. riser, while at a remote point a 1¼-in. riser might carry only 60 sq. ft. A tremendous amount of pipe is wasted in the heating business by using excessive sizes. To design a system of this kind requires great accuracy, but gives economical results.

In the heating business we more often make the mistake of using pipe too large rather than pipe too small, particularly in the smaller installations. In hot-water piping with forced circulation it is absolutely necessary to work from friction if uniform circulation and no short-circuiting is expected.

**Pipe Coverings.**—We have some very good information on the subject of pipe coverings above ground. We are just acquiring a little information in regard to pipe coverings below ground. I have been making some experiments on pipes buried in the ground without any covering. The surprising thing in these experiments is the great distance that heat is transmitted through the ground. It is possible to detect a steam pipe under ground 20 ft. away.

We also find that the condensation below ground is less than the condensation in the air. Our latest experiments show that there is less condensation with the steam passing through the pipe at a good velocity than with the steam in a quiescent state in the pipe. Of course, the deeper the pipe is buried in the ground, the less is the heat transmission, and if we were to bury a pipe to a sufficient depth it would be unnecessary to have any covering at all—the ground would serve as its own heat insulator—so that the deeper we run heating ducts and heating pipes the less we need insulation. This fact is often lost sight of. Exact data in regard to these facts are not available, but as a number of experiments are being carried on we undoubtedly will soon be able to make some exact statements.

## Shipping Bulk Cement in Gondolas and Unloading With Grab Bucket

Gondola cars were used successfully last year by several contractors for transporting bulk cement for construction jobs. Tarpaulins stretched over frames in the car to form a gable roof protected the cement from rain and wind. In some cases the cement was unloaded by hand shoveling into wheelbarrows, but on one large job it was handled by a grab bucket and locomotive crane. On this particular work over 14,000 bbl. were unloaded by the grab bucket and it was estimated that the loss of bulk cement was less than the loss would have been with sacked cement.

## Present Knowledge of the Setting Action of Cement and Plasters

In order to focus attention on the gaps existing in the present knowledge of setting action that occurs in cement and plasters an international discussion of the subject was held last winter by the Faraday Society of London. The discussions presented at the meeting are summarized in Concrete as follows:

**The Setting Process, in Plasters and Cements.**—Dr. C. H. Desch, University of Glasgow, opened the discussion with a paper on "The Mechanism of the Setting Process in Plaster and Cement."

The setting of plaster occurs in a manner which has been satisfactorily explained by Le Chatelier, through the formation of a supersaturated solution and crystallization of hydrated gypsum in spherulitic groups of needles. The same explanation may be applied to the setting of soluble salts, of magnesian and other similar cements, and of barium silicate. In regard to the more complex Portland cement class, two rival views have been maintained. On the one hand, Le Chatelier holds that the basic silicates and aluminates which constitute the cement form supersaturated solutions, and that the products of hydrolysis then crystallize in the same manner as plaster, while other investigators adopt the view of Michaelis, that the products are of a colloidal character, and that subsequent processes of crystallization play little, if any, part in contributing strength to the mass. The most recent investigations, those of the U. S. Bureau of Standards in Washington, confirm this explanation. When closely examined, it is seen that the difference between the rival hypotheses is partly verbal. It is admitted that the crystals which are formed when cement sets are exceedingly minute, even of ultramicroscopic dimensions, in which case the surface forces become comparable with those which determine the crystalline form. One may adopt the view of von Weimarn, that the passage from the crystalline to the colloidal state with diminishing size of particles is a continuous one. The size of the particles formed in the setting of cement is undoubtedly very small. The differences between the observations of different investigators may be attributed in part to experimental conditions, small quantities on a microscope slide yielding crystals more readily than a mass of cement gaged as in use.

**Crystalloids Against Colloids in the Theory of Cements.**—Professor Henry Le Chatelier, Paris, sent in a contribution to the discussion, entitled "Crystalloids Against Colloids in the Theory of Cements."

The author considers the theory which attributes the hardening of cements to certain colloidal properties of the material to be devoid of sense, for a colloid is taken to mean a body capable of hardening, and thus the theory is merely a definition. All very minute insoluble bodies give colloidal suspensions. The absorptive power of these bodies is only a particular case of much more general properties. Only insoluble bodies can preserve an extreme state of subdivision, hence colloids never show any discernible crystalline form.

In plaster, crystals may not be visible, but that is only due to their extreme minuteness. When the humid hydrated plaster is left to itself, crystals become discernible in time. Similar considerations apply to the calcium aluminates. In the hardening of Portland cement calcium silicate is the essential element; by analogy with barium silicate, hydrated calcium silicate may be said to crystallize, but in minute crystals, initially of colloidal dimensions, but in course of time they grow. As the mechanical resistance does not diminish with time, the colloidal state has nothing to do with the hardening, the explanation of which is the progressive crystallization of hydrated compounds of cement from a supersaturated solution, produced by the greater solubility of the anhydrous compounds. The crystals produced from such solutions are in the form of elongated needles, and the entanglement and close adhesion of these causes the solidity of the mass.

**The Agglomeration of Granular Masses.**—Professor F. G. Donnan, F. R. S., contributed a paper on "The Agglomeration of Granular Masses."

Attention is drawn to the four principal factors which tend to cause the caking, binding, or setting of granular materials, namely, the presence of unequally distributed stresses, of granules of unequal size, of unstable or metastable forms, and of sheared crystal faces. In all of these cases the material under one of the stated conditions is more soluble than the other forms; thus solids under stress are more soluble than when unstressed [illegible] metastable than [illegible] surface of a [illegible] stable crystalline [illegible]. Hence if the two forms exist side by side in contact with a solvent the material will be dissolved from the one form and reprecipitated on to the other form, and so bridges of [illegible] will be produced which will cement the [illegible]. The operation of molecular forces under these conditions is fairly well understood but it is not [illegible] by many occupied with industrial problems.

**The Constitution and Hydration of Portland Cement.**—A. A. Klein, Worcester, Mass., sent a paper on "The Constitution and Hydration of Portland Cement."

A short historical sketch of [illegible] the lines of Portland cement from the time of Vicat to the present is given. Three theories have been brought forward as to the constitution of cement: (1) That entailing solid solutions, (2) that of a lime-silica-alumina compound, (3) the presence of separate silicates and aluminates differing in hydraulic properties. Of these the third one is undoubtedly correct, and the essential compounds of cement are tricalcium silicate ($3CaO.SiO_2$), tricalcium aluminate ($3CaO.Al_2O_3$), and the beta modification of calcium orthosilicate ($2CaO.SiO_2$).

The presence of free lime denotes under-burning, while the compound $5CaO.3Al_2O_3$ may be present as a result of under-burning or of a raw material mixture low in lime and high in alumina. Magnesia in small amounts replaces lime in the silicates and aluminates, and iron occurs coloring the dicalcium silicate, as well as in a deeply colored isotropic flux material. The chemical changes involved in the burning of the clinker are discussed, as are the temperatures of formation of the various essential constituents. A summary is also given of work done on the hydration of these constituents under varying conditions, with a special reference to the new compounds formed and the speed of reaction with water. The hydration of cement itself is then considered from the time of mixing until after 28 days, and the conclusions are drawn as to the constitution of a cement with a view to obtaining the best setting cement from a standpoint of expansion, porosity and disintegration through external agencies.

**The Setting and Hardening of Portland Cement.**—A paper by G. A. Rankin, of the Geophysical Laboratory. Washington. entitled "The Setting and Hardening of Portland Cement," was read by Dr. C. H. Desch.

The paper records an experimental study of the hydration of the separate constituents of Portland cement clinker, namely, the minor constituents, lime and $5CaO.3Al_2O_3$, and the major constituents, tricalcic aluminate, dicalcic silicate, and tricalcic silicate. From this study it is seen that the initial set in Portland cement is probably due to the hydration of tricalcic aluminate; that the hardness and cohesive strength at first are due to the cementing action of the amorphous material produced by the aluminate and of tricalcic silicate; and that the gradual increase in strength is due to further hydration of these two compounds, together with the hydration of dicalcic silicate.

The value of Portland cement depends upon the fact that when finely powdered and mixed with water an amorphous gelatinous-like material is formed on the individual grains, cementing them together. This amorphous material results from the major constituents, tricalic silicate, dicalcic silicate and tricalcic aluminate. Of these constituents, the compound tricalcic silicate, which makes up about 30 per cent to 35 per cent of an average normal Portland cement, is the one which hardens and develops the greatest strength within a reasonable time. This is due to the gelatinous hydrated silica which is readily released when this compound, in a finely powdered state, is mixed with water. The essential process for the manufacture of Portland cement is the formation of this compound. Unfortunately, the increase of the percentage of the tricalcic silicate does not appear economically possible at present. A more feasible plan of attack for improving cements would appear to be to release hydrous silica from some compound such as dicalcic silicate, which contains a higher percentage of silica than tricalcic silicate, by the dissolving action of some suitable electrolyte. Investigation along these lines may result in the discovery of a cement which will enable us to prepare a concrete closely approaching the ideal; grains of sand cemented together with hydrous silicate—the toughest of sandstones.

The Colloidal Theory of Setting. [illegible] the similarity between the setting of cement and the behavior of zeolites towards water. These minerals lose water by careful heating and become non-transparent, but the original transparent crystals are reformed by simple immersion in water. The author had produced zeolitelike compounds by interaction between feldspar, salt and lime at [illegible]

[illegible]

**Ancient and Modern Mortar.**—W. J. Dibdin read a paper on "Ancient and Modern Mortar," of much historical interest.

[illegible] samples.

An important point is that relating to the quantity of lime used. In some instances, the volume of lime is measured as dry unslaked lime as received from the kiln. In others, the lime has been first "dry-slaked" and the required quantity taken from the powdery mass, which has a volume per unit of weight of unslaked lime greater than that originally. In some cases the slaked lime is first made into a "putty," kept for a time, and then measured in that condition. All statements of proportions of lime to aggregate are generally given in terms of volume unslaked lime.

The analysis of a series of ancient mortars showed that the volume of aggregate to 1 volume of unslaked lime varied from 0.4 to 3.7, but the average of these was about 1, as compared with the modern practice of 3. The best results of a large number of mortars prepared for experimental purposes showed, out of 15 samples, that 11 contained 2.0 to 2.5 of aggregate to 1 of lime. The ancient mortars therefore contained more lime than is considered permissible in modern practice.

Modern specifications of the aggregate to be used for the mortar generally state that this is to be "clean, washed sand, etc." The results of the analyses of ancient mortars of the 12th and 13th centuries, and that of the London Wall, showed that the proportion of aggregate was not only less, but its character was largely that of gravelly sand with clean ferruginous clay.

In the samples of mortar from Allington Castle, early 13th century, the relative proportions of lime to sand, etc., were 1 to 1.7, 1 to 1.1 and 1.9. The percentage of clean ferruginous clay was respectively 8.6 per cent, 3.66 per cent and 4.0 per cent on the sand, which was fairly coarse.

Samples of Roman mortar contained clean lime and broken brick only; while another from Threlfall Castle, near Hythe, contained clean flint and pebbles for the aggregate.

As showing the character of some of the mortar used after the Fire of London, a sample from Painters' Hall, built by Sir Christopher Wren, contained lumps of lime, some soft and some hard, the "sand and grit" consisting of broken red brick and organic debris, evidently old rubbish from the ruins of the Fire.

The results of special experiments show distinctly the reason of the advantage gained by the early builders in fixing their ratio at about 1 to 2 and the use of a coarser aggregate. The modern rush after economy, by reducing the quantity of lime, is very largely responsible for the falling off in quality.

The use of clay is disadvantageous with white chalk lime and greystone lime, but with blue lias lime a marked improvement is sometimes obtained.

An essential factor in regard to the strength of mortar is that relating to the voids between the particles. A mortar made with a sand having 40 per cent of voids had a crushing strength of only 70 lb. per cu. in., while with a sand having only 23 per cent of voids the crushing strength was 154 lb.

The suggestion that soluble silicates are formed in the course of time is not borne out in the author's experience. The examination of numerous samples of ancient mortar revealed the presence of no more soluble silica than is normally found in ordinary fresh-made mortar. Certain cases are met with in which the soluble silica is much higher, but in such instances the character of the mortar leads to the conclusion that trass or pozzuolan, etc., had been employed.

The setting of mortar was ascribed by Graham to the fact that "on drying, the mortar binds the stones between which it [illegible] to form a hard mass solely by the attraction of aggregation, for no chemical combination takes place between the lime and the sand, and the stones are simply united as two pieces of wood are by glue." "From the minute division of the silica and alumina in hydraulic mortar, their combination with lime is more likely to occur than in ordinary mortar. Still, the fixing of the hydraulic mortar [illegible]

**Effect of the Addition of Slag on the Setting of Cement.**—A paper by E. Deny, I. A. M., Ghent, and E. H. Lewis, M. A., Wishaw, on "The Effect of the Addition of Suitable Slag on the Setting Properties of Portland Cement," was read by Mr. Lewis.

The authors were not able to communicate results of laboratory research into the setting of Portland cement, and gave only certain results which had been obtained by them in the manufacture on an industrial scale of the class of cement which in German would be called "Eisen" Portland. These, as far as they go, confirm the results given by Dr. Passow.

The cement made from blast furnace slag is, of course, like other Portland cement, made from limestone and clay. But a portion of the limestone and the bulk of the clay are subject to a double burning, being first passed through the blast furnace. Ninety per cent of the lime in the slag which they had used came from the limestone used as flux in the furnaces, while, roughly, 70 per cent of the silica came from the ores and 70 per cent of the alumina from the coal used in Scottish practice.

Cement clinker made from such slag and limestone, on account of its comparatively high alumina-to-silica ratio, gives generally a quick setting cement. But this property is capable of adjustment by the use of a suitable limestone, and by the addition of properly granulated slag. By these two expedients the setting time can, if required, be reduced to that of a medium of slow setting cement. Considerable objection is sometimes raised to the addition of granulated slag. The authors' experience had been that such an addition, up to 30 per cent of the total, not only regulates the setting time of the cement, but adds considerably to its tensile strength.

Not only is this improvement possible to the high alumina cement made from clinker, of which such slag and limestone are the constituents, but the effect is the same in the case of Portland cement made from the usual material. It had been stated by a very competent authority that German "Eisen" Portland cement was merely a genuine Portland cement adulterated with slag. This statement led the authors to make experiments to determine the result of adding granulated slag to a standard brand of Portland cement.

The results of tests made with the cement neat and with the cement mixed in the proportion of 70 to 30 with Wishaw blast furnace granulated slag are given in the paper.

There was one very interesting point to which they particularly wished to call attention. It is generally admitted that quick-setting Portland cement has less strength after a time than cement which sets more slowly. With their cement the high content of alumina makes it possible, contrary to the generally accepted theory, to use without fear of expansion, a greater percentage of lime in the clinker than is usual. The result of grinding such a clinker without any addition of raw slag is a very quick setting cement; but if suitable slag be added, such clinker gives a cement of reasonable setting time, which soon attains so great a strength that it has reached 1,300 lb. per sq. in. at 28 days.

This result was due to the presence in the clinker of a large proportion of "alite" consequent upon the high percentage of lime, which is greater than could be carried in ordinary Portland cement.

They suggested in conclusion that the quick setting and hardening was due to the beneficial effect of the large proportion of hydrolysed aluminate upon the subsequent hydrolysis of the silicate of lime; further research into this point, which is peculiar to such high alumina cement, would be of interest.

Percy C. H. West also spoke on the effect of the addition of slag to Portland cement:

The origin of the discussion of this subject is to be found in the discovery of the cementitious properties of blast furnace slag and the production of a pozzulanic cement from this material.

Michaelis, and about the same time Erdmenger, in the seventies and eighties observed the notable results obtained by the addition of pozzuolanic materials to Portland cement mortars, and these results were the first blows struck in a battle which is apparently not yet ended.

The publication of a circular by the "Vorwohler" Portland Cement Works, which were selling a Portland cement to which blast furnace slag had been added, describing their cement as a "Portland cement improved by the addition of silica in an active form" was the next important incident in the conflict.

The Association of German Portland Cement Manufacturers then began to take active steps to show that such additions were adulterations and nothing more. Dyckerhoff was one of the strongest supporters of this view. On the other side was Dr. Passow.

The work carried out on an extensive scale by the Royal Prussian Material Testing Station generally agreed with the experience of the speaker, that while a Portland cement of relatively poor quality was often improved, a first-class Portland cement did not have its mechanical properties improved by such an addition. Yet he found that with such additions products could be obtained quite equal in mechanical properties to many Portland cements.

There was one point which had not been recognized, namely, the sensitiveness of Portland cement to which such additions had been made to sulphates contained in aggregates with which the cement was used. Tests which had been carried out by him showed that in cold, wet weather, expansion of the concrete leading to most undesirable results was liable to occur where what may be described as an "Iron Portland Cement"—that is to say, a Portland cement to which slag had been added—was used; while, when Portland cement had been employed with the same aggregate and otherwise in similar conditions, such undesirable results did not occur.

The whole question had been energetically debated in the past, and for guidance in coming to a conclusion one must have regard to the prior publications concerning the matter.

**Setting of Portland Cement in Relation to Engineering Structures.**—Bertram Blount read a paper on "The Setting of Cement and Its Relation to Engineering Structures."

The author, after indicating the lack of exact knowledge of the nature and cause of the setting of cements of all classes, deals with the typical case of plaster of Paris, and points out that there is at present no true parallel between that and the more important case of Portland cement. He mentions modes of determining the setting of Portland cement and shows that these from the nature of the material cannot be exact, though sufficient for their purpose when such cement is in question. When, however, the setting of concrete has to be taken into account, the setting of the cement itself, though useful as a guide, is not conclusive, both because of difference of climate and the dilution of the cement with various aggregates, and he pleads for fuller investigation.

The subject was then thrown open for general discussion by those present.

W. D. Caroe gave some practical illustrations of the value of scientific investigations into the problems connected with cements and mortars from the point of view of the builder. One case illustrated was the stability of St. Paul's Cathedral. Another case led him to question the wisdom of excluding clay from mortar, as was done in the standard specifications adopted by architects. The expansion of cement containing slag needed investigation, as did also the chemical effect of cement upon stone. As ordinarily used, cement was often a source of great danger to old buildings.

A. Binns spoke of the setting of cement from the point of view of the constructional engineer. Initial set must not take place until the material is in position, but once in place the setting and hardening should be rapid. He referred also to the improvements in cements during the last 20 years, largely due to scientific research. The percentage of water used in concrete was of great importance, and it was not sufficiently controlled.

W. J. Cooper considered that Portland cement as made today could be free from any danger of future expansion. Researches on the time of setting should be carried out, with a view of improving setting qualities.

T. Martin Lowry, F. R. S., spoke of the difficulties that often arose on account of the setting into a hard mass of salts like ammonium nitrate. The fundamental cause was recrystallization, but in the absence of moisture caking did not take place. Both caking and disintegration were broad, general phenomena, and further research was called for.

F. C. Hemmings thought that to explain the setting of plaster of Paris it was sufficient to assume that the dihydrate was deposited in the interstices of the tiny particles and that the whole mass was not converted into dihydrate. In the case of crystalline salts the presence of a solvent medium was essential for setting. He gave some interesting details with regard to the conditions under which such setting took place, and also referred to some commercial applications of these problems.

Dr. W. Rosenhain, F. R. S., included the setting of metals in the more general analogous phenomena referred to by Dr. Donnan and the last speakers. Here also setting was caused by crystals adhering to one another very powerfully. The welding of metals was in that sense also a case of setting. He discussed the mechanism of crystal-adhesion, which was not due to frictional cohesion, and attributed it to a film of amorphous material between the crystals which, possessing the properties of undercooled liquid, had no planes of cleavage or weakness. The theory was borne out by what had been said about the setting of cements and of crystalline aggregates.

Dr. C. H. Desch summed up the results of the discussion. The [illegible] has been shown to [illegible] a difference in terms. The [illegible] [illegible]

## Concreting Plant for Long Viaduct Mounted on Sled and Moved Along as Work Progressed

In constructing the 1,080-ft. concrete viaduct approach to the Central Ave. bridge at Kansas City, Kan., described elsewhere in this issue, all concrete was poured from a tower. The tower complete with mixer and hoisting equipment were mounted on a large sled, and were moved alongside the structure as the work progressed. Switch tracks were adjacent to the viaduct for a good share of its length, and the sand and rock could therefore be delivered very close to the mixer. The material was in general shoveled direct from the cars onto shoveling platforms composed of old steel scrap plates. The mixer was charged with barrows, a short incline being moved along with the sled to provide an easy runway. Cement was stored in a warehouse at one end of the viaduct and hauled by wagon to the mixer as needed. The plan worked out very well. If a stationary plant had been installed, the length of the viaduct, as well as the number of turns, etc., would have caused some annoyance in the delivery of the mixed concrete for the comparatively small force of men employed, but by arranging the movable plant all of the workmen, those mixing the concrete as well as those placing it, were under the direction of one superintendent, which would not have been the case, of course, with a remote mixing plant.

Viaduct Construction With Movable Concreting Plant.

**Salvaging Lumber with Resawing Plant.**—The Chicago, Burlington & Quincy R. R. is effecting a saving of $6,000 to $8,000 a year by resawing old lumber at a plant at Galesburg, Ill. The plant consists of a Berlin No. 3 pony band saw with a 30-ft. carriage, and a 36-in. cut-off saw. Both saws are operated by electricity. The sawmill gang consists of a sawyer and four helpers. Two of the latter bring the lumber to the saw and the other two pile it or load it into cars for shipment. The old lumber is sorted when received and sawed up as orders come in. The labor cost in 1917 was as follows:

| | [illegible] |
|---|---|
| On the resaw | [illegible] |
| Cutoff saw | [illegible] |

## Visible Record System for Expediting Construction Contracts

A system that provides a visible record of each contract and of the status of the questions on which decision is pending is employed by the Public Works Office of the Philadelphia Navy Yard in handling the large amount of construction now under way at that point. The plan is described by Civil Engineer De Witt C. Webb, U. S. Navy, in the April Public Works of the Navy.

The principal subdivisions and their heads are as follows:

General yard development, maintenance and repairs: Assistant civil engineer.

Day labor work: Two assistant civil engineers, one in office and one outside.

Yard transportation, expediting shipments, sand and gravel production and distribution under commandeer orders: Supervising engineer.

Records and clerical: Chief clerk.

Design, drafting, checking plans, etc.: Chief draftsman.

Electrical and mechanical installations and contract inspection of similar work: Electrical aid.

Engineering contract inspection: Expert aid.

A supervising engineer acts as general assistant to the public works officer, particularly in the more important engineering matters, and a stenographer acts as secretary.

The inspection force is further divided into a number of sections, each under an experienced man who is responsible for the proper inspection of all contracts under him.

Each of these section inspectors has under him a chief inspector for every contract, who is in charge of the inspection work on that contract. Under each of these chief inspectors is a sufficient force of pile inspectors, concrete inspectors, etc., thoroughly to cover the work. On the larger contracts the chief inspector has also enough men to do all the necessary surveying for the purpose of giving lines and grades or making estimates for payment. Each section inspector is also able to organize a survey party for these purposes without disarranging the work of his chief inspectors.

Each contractor, on being awarded a job, is required to submit a "progress chart" showing the dates on which he anticipates commencing and finishing the major items of work in his contract. These charts are plotted on cross-section tracing cloth, and on them is posted weekly the actual quantities of work done. It is thus an easy matter to ascertain whether or not the work is progressing as anticipated.

Once a month each section chief makes a report of the amount of work done and the quantities of material used on all contracts under his charge. After this has been checked against an independent estimate prepared by the chief estimator, a voucher is prepared for monthly payment.

Before beginning work contractors are required to submit for approval samples of the various materials entering into their construction. These samples are compared with the specification requirements, are accepted or rejected in writing, and a typewritten sheet glued or tied to each sample, showing the contract to which it pertains and a reference to the letter accepting or rejecting it. A room has been fitted with shelves and a space provided for each contract, where all the samples submitted for that work are assembled for convenient reference. When delivery of materials begins, inspectors compare the accepted sample with the material actually delivered.

With a large number of contracts under way, it is inevitable that many differences of opinion regarding final settlements should arise, and it is exceedingly necessary to keep a complete and accurate history of every contract. This is accomplished by having each inspector make out a daily report, showing not only the amount of work done, but the points at which work was being prosecuted, the reason for changes and delays, and all other matters that might have a bearing on the final adjustment of the work. From these reports is made semi-monthly a typewritten digest of the work accomplished on each contract. These digests frequently furnish sufficient information for settling questions that arise, and when more detailed data are required it is easy to trace the matter back to the original daily reports. As soon as a contract has been disposed of the reports for that contract are bound and filed.

Another most important feature of the organization is to expedite attention to correspondence and other matters relating to the large number of contracts. Such matters are handled in a manner that has proved effective. Each letter or paper relating to a question which should be handled by one of the assistants is attached to one of the small slips shown herewith, which shows the name of the firm or person from whom the papers have come, the date received, a consecutive number, the subject, the name of the man to whom it has been referred, and the date of reference. These slips are made out in triplicate:

From:
Date: Let. No. Ind. No.
Subject:
Ref'd to:
Date:

On a large board secured to the wall in the office of the public works officer are a number of columns, each of which is headed by the name of an assistant. Under each of these names are thumb-tacked, in consecutive order, one copy of each slip describing matters that have been referred for action to the man whose name heads the column. When action has been taken, the letter answered, etc., the papers in each instance come back to the public works officer for his information, and as soon as received the slip relating thereto is removed from the board. One copy of each slip also goes to the file clerk for his information.

It is thus possible to trace any matter which has come up for decision and has not been dealt with promptly. Moreover, it is easy to tell in general how promptly each man is in disposing of his important business, and to follow up matters requiring special haste without waiting for further reminders from the original correspondent. The board also indicates at a glance how much of a load each one of the assistants is carrying.

The system outlined has enabled the public works office in question to take care of its tremendously expanded construction business without confusion or delay, and furnishes an unusual degree of insurance against the sidetracking of important matters.

**Record for Keel Laying.**—In reporting to the Shipping Board the launching of the Quinnesec, the Terry Shipping Co. of Savannah, Ga., stated that within 90 seconds after the ship left the ways another keel had been placed in position on the vacated blocks.

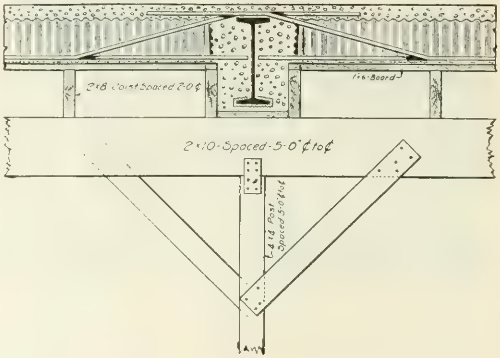
# The Core Type of Reinforced Concrete Floor Construction*

The core type of reinforced concrete floor construction, in which pressed steel cores are used to produce a series of parallel connected tee beams, has come into extensive use.

This type of construction is exploited principally by companies manufacturing specialties in pressed steel products and the forms are known by various names, such as "Pressed Steel Cores," "Steel Forms," "Metal Tile," "Floretyles," "Steel Tile," etc., and also known to many as the "tin pan system." This system provides a simple type of floor construction which may be supported by walls or beams of steel or reinforced concrete poured in conjunction with the floor system.

**Core Details.**—The various features that go to make up the system are as follows:

Tee Beams.—The floor structure is in reality a series of connected tee beams presenting a flat surface on top. The flange, usually from 2 in. to 3 in. thick, forms the compression member of the tee section, and the web or rib of the tee, which encases the reinforcing steel, projects below the slab. These ribs are from 4 in. to $6\frac{1}{2}$ in. in width, generally spaced from 24 in. to $31\frac{1}{2}$ in. on centers and from 4 in. to 14 in. in depth.



Longitudinal Section Showing Cores and Reinforcing Rods in Joists.

Ceilings.—In the great majority of cases a metal lath ceiling is secured to the bottom of the joists, which, upon being plastered, produces a flat ceiling surface. There is, however, a tendency to extensive use of the construction in buildings for factory or storage purposes, which are necessarily designed for heavy loads, and where the flat ceilings are not required. In these cases the cores are removed, and upon removal a concrete ceiling with a surface similar in appearance to a wood joint floor is produced.

Special Features.—The special feature in the core type of construction is in the use of a broad trough-shaped pressed steel core or center, placed in an inverted position and supported by wooden skeleton centering. These pressed steel cores form the centering for the sides of the rib and the bottom of the flange, while the wooden supports form the centering for the bottom of the rib of the tee beam. The cores are varied in design and weight to meet requirements of either permanent or removable centering.

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*From a paper by A. H. Bromley, Jr., Chief Engineer, Sales Department, Berger Mfg. Co., presented June 29 at the convention of the American Concrete Institute.

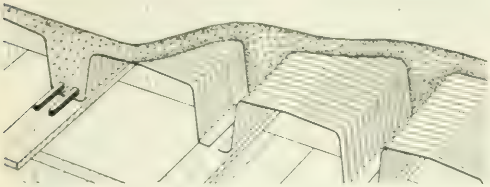
Removable cores are usually made in from 16 to 22 gage and non-removable in from 24 to 28 gage material. Where necessary, the cores are tapered in width to increase the width of rib adjacent to supports, to make proper provision for the maximum shearing stresses, or for requirements of negative bending moment. Suitable end caps are provided to close up the ends of the lines of cores.

Dimensions.—The dimensions of the cores are approximately as follows: Stock lengths, 2 ft. 6 in. to 4 ft. Regular widths, 20 in. and 25 in., with special widths of 6 in., 8 in. or 12 in. and over, made for narrow spaces. Depths, 4 in., 6 in., 8 in., 10 in., 12 in. and 14 in.

Shape of Cores.—The cores are made with sides slightly tapered and usually with a slight arch in the tops.

Beam Spacing.—It may be readily seen from the data given above, that the skeleton wood centering to support the cores and form the bottom of the rib will require horizontal supporting members only 6 in. or 8 in. wide and spaced 24 in. to $31\frac{1}{2}$ in. on centers, insuring great economy in material and labor as well as speed in erection of the carpenter work.

**General Methods of Construction.**—There are two general methods of construction, differing principally in the installation of the metal lath ceiling under the cores.



Cross Section Showing T-Beam Construction.

One method is where a light gage ribbed expanded metal lath, or a stiff heavy gage lath is laid over the forms before the cores are placed. The concrete when poured engages the meshes of the lath in the bottom of the ribs, thereby securing it in position. It is generally found advisable, however, to secure wire to the lath, which wire is placed so as to extend up into the concrete rib, and thereby form a more secure fastening.

The other method provides for regular ceiling lath to be installed after the wood centering has been removed from under the construction. The cores are secured by lightly nailing them to the wooden forms, when wire hangers (consisting of a hooked end and straight portion about 15 in. to 18 in. long) are pushed through the holes previously punched through the tops or sides of the cores, and when concrete is poured, these hook ends are securely held by it. After the concrete is poured and the centering removed, furring bars or rods are suspended under and at right angles to the ribs by securing them with these wires. The metal lath is then wired to the furring rods in the usual manner. Advantages are claimed for this method in that the ceiling plaster is kept away from the concrete, thus allowing an air space above the entire plastered ceiling. This eliminates discoloration of the white coat, which discoloration is usually in evidence where any type of joist construction is used which does not provide continuous air space. A further advantage of this method is that the centering can be removed for re-use.

# The Engineering Council Urges Conservation of Technical Engineers

[illegible]

Technical engineers of every branch of the profession who are taking part in the war activities of the army and navy are alarmed at the unfortunate waste of technical training caused by the drafting and enlisting of engineers for regular service, with little or no regard for their technical attainments. These technically educated and experienced men are essential to the successful conduct of the war, and cannot be replaced. There is continuing evidence that America is repeating in some measure England's mistake of sending technical men into the ranks, when they should be carefully conserved for special duties in the fighting forces or on the technical staffs of the army, the navy and the essential war industries.

These facts have been forced upon the attention of engineers who have been co-operating with the Government through the Naval Consulting Board, the National Research Council and the Engineering Council. Upon these organizations requests have constantly been made for engineers, chemists and other technical men for a great variety of military services. Thousands of names have thus been furnished to the Government departments and bureaus. The Engineering Council especially has devoted attention to this personal work through its committee, known as American Engineering Service, which has available classified lists of approximately 25,000 engineers, and, besides, unclassified lists of many more. It is from these lists, directly or indirectly, that most of the names have been selected for war service.

The Engineering Council was founded by the American Society of Civil Engineers, American Institute of Mining Engineers, American Society of Mechanical Engineers and American Institute of Electrical Engineers, and other engineering societies are cooperating with it in this service, the total membership represented by these organizations, being approximately 50,000. Already from 10 to 15 per cent of the members of these several organizations are in the uniformed services of the country, and it is safe to say that a large majority of their remaining members are in the Government civilian service or otherwise directly or indirectly engaged in the war. Engineers do not seek to avoid fighting, but earnestly desire to be given opportunities for fighting and other services in which they can be most effective and which cannot be performed by others.

It is known that through the Committee on Classification of Personnel in the War Service Exchange (of the War Department), and in some other ways, efforts are being made to counteract the tendencies toward the loss of our technical men in the ranks of the army and navy. It is believed, however, that these efforts are insufficient, and that they should at once be supplemented by other stringent measures dealing with the subject in the draft boards and recruiting stations.

In view of the foregoing, the Engineering Council, created to provide means for united action and to speak authoritatively for its member societies on all public questions of common interest to engineers, respectfully offers the following:

[illegible]

and tank service, in shipbuilding, and in many other assignments, and,

Whereas: Through draft and otherwise many of these irreplaceable men have been and are being diverted so that their special qualifications are not being utilized; be it therefore

Resolved, That in the opinion of the Engineering Council technically trained men of all ages should be enrolled and conserved for technical duties, and special efforts should be made immediately by the War and Navy Departments to find and record such men among drafted and enlisted forces, and to assign them to places in which their special qualifications are needed; and be it further

Resolved, That the Engineering Council offers to assist the War and Navy Departments in locating and classifying such men, if its assistance be desired, provided these departments will give the necessary facilities for collection of information about engineers now in the Army and Navy, or whose names are upon the selective draft lists.

These resolutions are offered solely in a patriotic spirit of helpfulness.

Alfred D. Flinn,
Secretary, Engineering Council.

## Advertising by Architects

The Publicity Committee of the Illinois Chapter of the American Institute of Architects has taken action on the changed policy of the Institute concerning advertising. At the May meeting of the Chapter it reported the following resolution:

Whereas, the American Institute of Architects, at the 51st annual convention assembled, revised the canons of ethics by eliminating Article 4, namely, "It is unprofessional to advertise."

And, whereas, the convention instructed the Board of Directors to revise Articles 12 and 13 of the "circular of advice" relative to principles of professional practice to conform to the above action;

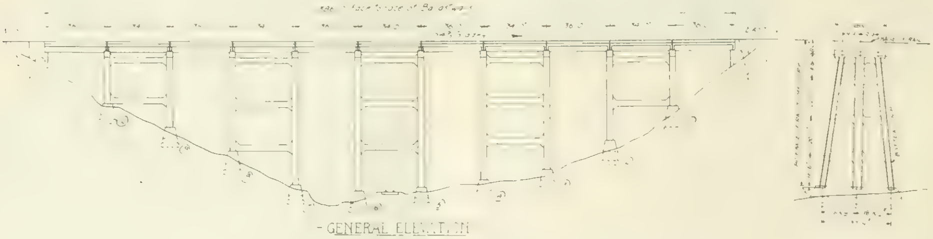


Fig. 1—Elevation of Belt Line Bridge and of Typical Bent.

And, whereas, it is deemed advisable for the Chapters of the American Institute of Architects to advise the board, and the board invites the co-operation and suggestion of the Chapters;

Therefore, be it resolved, by the Illinois Chapter, A. I. A., that Clause 12 of the "circular of advice" be revised to read as follows:

"The Institute relies upon its members to keep whatever advertising they may do within the bounds of truth and good taste, and of such character as to maintain the high ideals of the Institute."

And, be it resolved, that the following two sentences be substituted for the first sentence of Clause 13: "Placing the architect's name on a building during construction and the signature on buildings after completion, in a dignified manner, is recommended by the Institute. Signs should be limited to the name of the architect, the initials of the Institute, and the address."

And, be it further resolved, that a copy of these resolutions be sent to the Board of Directors of the American Institute of Architects.

## Placing 52-Ton Pre-Cast Beams on North Toronto Bridges of C. P. Ry.

In connection with improvements to its through line in North Toronto, Ont., the Canadian Pacific Ry. has replaced two single-track steel bridges with reinforced concrete structures of somewhat unusual design. The work is described in The Contract Record, to which we are indebted for the matter in this article.

A steel addition to the old steel bridge to widen it out was first thought of and finally discarded. The plan of entirely new steel structures was also discarded, owing to the high cost of steel. Several reinforced concrete designs were considered and plans for an arch bridge discarded when tests showed that the clay bottom petered out and became a near quicksand. Reinforced concrete bridges of quite unusual design were eventually decided upon. They are of a reinforced concrete trestle type resting on continuous footings under each bent. The bents contain four posts (three in the Belt Line bridge) tied together with the outside posts battered. The trestle spans are 34 ft. and the spans between the trestles are 36 ft.

**General Features of the Bridges.**—Probably the most unusual feature of these bridges is the pre-cast I-beams which form the decks. In fact, the whole of the superstructure carried on the reinforced concrete towers is pre-cast before being set in place.

Sixty-six T-beam units weighing approximately 52 tons each will form the deck slab of the bridge over Reservoir Ravine. The curb sections, handrail posts and sidewalk slabs have all been pre-cast and all that remains is the settling of these units to complete the structure.

The contractors for the reinforced concrete work for the bridge over Reservoir Ravine were Wells & Gray, Ltd., Toronto. The contract for the construction of the bridge over the Belt Line Ravine was carried out by the Dominion Construction Co. of Toronto, who also erected the temporary trestle work at this point.

The bridge which is being constructed over the Belt Line Ravine is a double track structure composed of five reinforced concrete towers of two bents each supported on continuous footings. The superstructure consists of 44 pre-cast concrete track slabs, 90 sidewalk slabs and 96 handrail posts. The concrete work of the new bridge is complete with the exception of rubbing down the concrete, which will probably be done after the superstructure is placed. It is stated that the contractors will use a cup-stone set on a spindle and driven direct by a small electric motor for the polishing of the exposed surfaces.

**Plant for Erection of Superstructure.**—James Finley, of Tweed, Ont., has the contract for placing the superstructure, the units of which were cast some months ago by the Dominion Construction Co. as part of their contract. His plant consists of two locomotive cranes, a number of hydraulic jacks and two sets of quadruple block and tackle. The locomotive cranes go down the mainline to the storage ground, which is about half a mile from the bridge, for the deck slabs. The cranes, one at each end, pick up the beam and set it on two railroad trucks placed about 8 ft. from either end of the slab. The forward truck is fitted with a draw bar and the heavy 100-ton crane engages this and draws the beam to the bridge site, where it is shunted onto a switch line running to the bridge trestles.

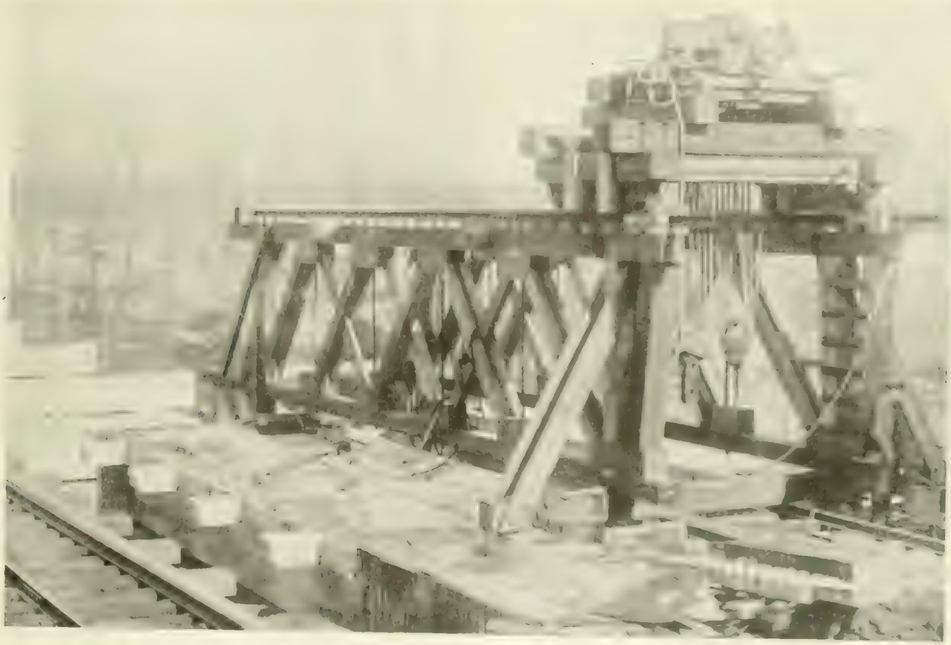


Fig. 2—Erecting Trestle and Traveler Note Outside Supports to Trusses and Heavy Quadruple Blocks.

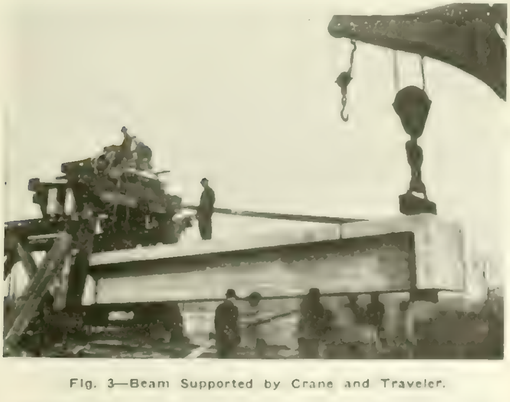


Fig. 3—Beam Supported by Crane and Traveler.

The tackle used for picking up the beam consists of two 12-in. I-beam sections fabricated like a box girder with two pieces about 14 in. wide. A heavy clevis is fastened to the center of this to engage the clevis on the crane block. Two rods 1½ in. in diameter and threaded on each end pass through the tackle and through the flanges of the beam close to the stem of the T-beam section and are fastened by means of nuts to a heavy plate on the under side. The apparatus for carrying the beams over the trestles is rather unique. It looks very much like two bridge trusses built of wood, with the lateral bracing and upper cross timbers removed. At the forward end the posts are extended to rest on the reinforced caps of the bridge bents. The other end rests on a heavy piece of timber, to which the trusses are bolted.

Two sections of rail are laid along the top chord and superimposed on these rails is a traveler. The traveler is constructed of dimension timber and is fitted with two trucks with double-flanged wheels. Two sets of quadruple blocks are fastened to the traveler and are used to carry the end of the beam. A section of timber is bolted to the top of this apparatus, to which the workmen snub the tackle rope when they lower the beam to its place.

**Method of Placing Pre-Cast Beams.**—The sequence of operations in placing a beam is as follows: The crane pushes the beam, on its trucks, along the spur until the forward end comes under the traveler. The blocks are then fastened to the beam using tackle similar to that previously described. The crane then picks up its end clear of the trucks and, after the beam is blocked in this position, picks up the rear truck and places it out of the way. Again engaging the beam, the crane picks up its end, raising it clear of the blocking, which is then removed, and the beam is lowered until the end touches the railway ties. By lowering the rear end, the beam teeters on the forward truck and the front end rises. The rope tackle is then tightened up and snubbed, and the crane, by raising its end, transfers the weight off the forward truck onto the traveler. The forward truck is then run back and, after the beam is again blocked up, is removed by the crane. The beam is now held in the air, as shown in Fig. 2, one end being carried by the crane, the other by the tackle mounted on the truck of the traveler. A piece of 6 by 6-in. timber is temporarily placed between the traveler and the crane tackle and a second piece between the beam and the crane itself. The crane now moves forward, pushing the beam and traveler ahead of it to the desired position. The beam is then lowered into place. The whole operation at the bridge site takes about 35 minutes.

The operation of moving the traveler forward to the next truss bent is easily performed. One of the cranes, operating on the existing line, which is parallel to the bridge, picks up the rear end of the traveler truss; the other crane picks up the rear end of this truss and both cranes move forward, carrying the truss to the desired position. After the beams are placed they will be grouted and waterproofed, expansion joints being left at the ends of the beams. The tracks will then be laid in ballast.

The work is being executed under the supervision of Mr. J. M. R. Fairbairn, assistant chief engineer of the C. P. R. The design was prepared under the supervision of Mr. P. B. Motley, Engineer of Bridges, Can. Pac. Ry. Co. Mr. J. H. Barber, with A. H. Munson as his assistant, is the engineer in charge of the work.

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**Two Government Housing Divisions to Work in Full Accord.**—A. Merritt Taylor, director of passenger transportation and housing, Emergency Fleet Corporation, and O. M. Eidlitz, director of housing and transportation of the Department of Labor, have adopted policies whereunder their respective activities will be carried on in complete cooperation and accord to the end that duplication of effort will be avoided and maximum results will thereby be obtained for the Government at a minimum cost with maximum efficiency. The two divisions will at all times be fully informed with relation to their respective projects; procedures, and all matters relating thereto; and all other information of the one department will be available for the use of the other at all times.

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**Three-Year Course in Engineering at Lehigh University.**—As a war measure Lehigh University has recast its four-year courses so that, by the elimination of a part of the usual vacations and by intensive work, students are now enabled to gain the University's degrees in engineering and in arts and science in three years. The revised schedules provide for three terms of fourteen weeks each year with shop and other practical instruction for engineering students in summer classes. By this arrangement students having the same amount of training as has regularly been given at Lehigh, and with military science and drill in addition, will be graduated a year earlier.

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**First Electrically Welded Ship Launched.**—A British yard is stated to have launched an electrically welded ship—the first of its kind. It is reported that work on a vessel of the same type will be started soon at Newark, N. J.

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# Design Features of Concrete Ship Developed by Government Department of Concrete Ship Construction

Essential facts on the design of the concrete ship developed by the Department of Concrete Ship Construction of the U. S. Shipping Board are given by Mr. R. J. Wigg, Chief Engineer of the Department, in a U. S. Senate Document made public early this month. The matter following is taken from the Document.

The vessel contemplated is of the same size, dimensions, and form as the 3,500-ton standard wood ship, except that the sheer line amidships has been slightly altered and no outer keel is fitted.

The general arrangement follows closely that of the above wood ship, including the number and location of bulkheads.

The propelling machinery designed for the wood ship has been provided for without essential change in this vessel.

The principal characteristics follow:

Length (P. P.), 268 ft.
Beam over shell, 46 ft.
Depth amidships (at side), 28 ft. 3 in.
Draft, 23 ft. 6 in.
Full load displacement, 6,175 tons.

COMPARATIVE WEIGHTS, CONCRETE, WOOD AND STEEL VESSELS.

| | Concrete. | Wood. | Steel. |
|---|---|---|---|
| Hull | 2,500 | 2,300 | 1,160 |
| Fittings, outfit and equipment | 191 | 191 | 180 |
| Propelling machinery | 206 | 206 | 200 |
| Margin | 75 | 80 | 60 |
| Ship (light) | 2,972 | 2,777 | 1,600 |
| Reserve feed | 80 | 80 | 80 |
| Ordnance | 23 | 23 | 23 |
| Fuel | 300 | 300 | 300 |
| Stores | 40 | 40 | 40 |
| Cargo | 2,760 | 2,180 | 3,057 |
| Total dead-weight | 3,203 | 3,123 | 3,500 |
| Full load displacement | 6,175 | 5,900 | 5,100 |
| Percentage dead-weight to full load displacement | 52 | 53 | 68.6 |

### Values of Metacentric Height, Stability, Period of Roll.

Metacentric Height.—The metacentric heights in the light (ship without cargo) and full load conditions are, respectively, 2.15 ft. and 2.2 ft. The best practice at the present time places these values between the limits of 1 and 3 ft. for vessels of this type and size. It will accordingly be noted that in this respect the vessel in question appears to be entirely satisfactory.

Range of Stability, Righting Arm, etc.—The maximum righting arm occurs at 51.5° and 46.5° for the vessel light and fully loaded, respectively, the extreme ranges being 89° and 81.5°, respectively.

Freeboard.—The freeboard amidships at side is 4 ft. 9 in. It is understood this is satisfactory to the representatives of Lloyd's Register of Shipping.

Period of Roll.—An attempt to investigate this theoretically is a laborious operation and of doubtful value. It is seldom attempted in the design of steel vessels. It is considered safe to say, however, that the concentration of relatively great weight in the decks and shell, as is the case in the concrete vessel, should aid materially in increasing the period of roll anticipated.

### Girder Strength or Strength of Vessel as a Whole.

The strength of the ship as a girder supported on the crest of a wave amidships hogging and also on the crests of two waves, one at each end, sagging, was calculated for five conditions.

The same basic assumption as to length, depth, and form of wave and the same method of procedure that is standard practice in calculating the strength of steel ships was followed throughout.

| Condition | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|
| Ship without cargo, hogging | 25,175 | 5.53 | [illegible] | [illegible] |
| Ship fully loaded, hogging | [illegible] | [illegible] | [illegible] | 766 |
| Ship without cargo, sagging | [illegible] | 1.28 | [illegible] | [illegible] |
| Ship light with [illegible] in forward hole to trim, sagging | 11,960 | 1.07 | [illegible] | 210 |
| Ship fully loaded, sagging | [illegible] | .84 | ²1.72 | [illegible] |

¹Keel. ²Deck.

Good practice in steel merchant ships for a boat of this type gives a maximum stress in the outer fiber of from 5 to 8 tons per square inch, figured on the same basis as given above for the concrete ship. In addition to the stress due to the ship acting as a girder, there is local stress between frames where the plating must act as a beam over that space. This action is seldom taken account of in steel ships, but has been given full consideration in the design of the 268-ft. concrete ship.

### Local Strength, or Strength of Individual Members Compressing Vessel Structure.

Transverse Strength.—Only in the case of naval vessels is it the practice to go into the transverse strength with any degree of accuracy. Either the sizes of frames are taken from the books of the classification societies, or the frames are figured as beams supported or fixed at keel, bilge, or deck, as the case may be. The complete ring in the concrete boat is figured with numerous cases of loading and keeling for every frame.

The strength of the transverse frames for the vessel was investigated for a large number of conditions of loading and for various immersions of the vessel. The transverse frames are designed to stand the outside water pressure with water to the gunwales and with minimum cargo load, for maximum cargo load and a sagging draft of 15 ft. 6 in., and for listed positions with loading slight and heavy; all of these conditions of loading to be met by the frames with stresses not to exceed 1,500 lb. per square inch in the steel. The results of the analysis agree with those of Dr. Bruhn, published in Transactions of the Institute of Naval Architects, 1901 and 1904. It is important to note from Dr. Bruhn's analysis it is clear that the design of the concrete frame is so made that the frame is working at the above-noted safe stresses under loadings that would develop double the steel stress in a standard steel frame of similar dimensions. In steel ships this local action between frames would increase the stress in the bottom plating of the ship acting as a girder from 5 to 10 tons, and in many cases to a much higher figure.

In this concrete-ship design the tensile stress in the reinforcement, due to the local bending, amounts to about 3 tons per square feet, bringing the total up to slightly less than 8 tons.

Bulkheads.—The bulkheads have been designed to carry a head of water on either side up to the deck. The collision bulkheads, fore and aft, were designed for 1,500 lb. per square inch in the concrete, and 16,000 lb. per square inch in the steel. The steel stress in the engine-room bulkheads was advanced to 20,000 lb. per square inch.

In the design of bulkheads for steel ships it is common practice to allow a unit stress in the steel of 22,000 to 23,000 lb. per square inch.

# Industrial Research

One of the leading features of the last annual meeting of the American Society for Testing Materials was the topical discussion on Cooperation in Industrial Research. This discussion was formally introduced by Dr. Henry M. Howe, Dr. John Johnston, Dr. Arthur D. Little, Dr. Charles L. Reese and Mr. Frank E. Gorrell, all of whom presented papers on various phases of the subject. Abstracts of the papers of Drs. Howe and Little follow:

## The Four Phases of Research

By HENRY M. HOWE.

**Four Distinct Parts to Every Research.**—Every research consists of four tolerably distinct parts: selection, planning, execution, and interpretation.

First out of the immeasurable area of our ignorance we select a certain limited field the exploration of which promises the greatest profit. The problem to be solved should be enunciated with perfect sharpness. The selection of this field demands today first a knowledge of the problems which are pressing on our military and other departments, and second, very sound judgment. In other times the pressing needs of the industry dictate the selection.

Next the research should be so planned that its results will have the greatest promise of yielding a clear and decisive solution of the problem, a sharp answer to a sharp question. This requires complete familiarity with the subject, and especially with existing knowledge and with the tests applicable. For instance, if we study the influence of a process on the mechanical properties of a metal or other product, we should either provide for tests which will measure directly the properties needed in the service in view, or if as usual we cannot reproduce in our tests the most trying conditions of service, then we should provide plural kinds of tests, increasing the number of kinds in proportion to the indirectness of their evidence as to fitness for service. Every kind of test which throws light on service fitness should be used. The consideration that new and unforeseen services are constantly developing argues for widening the range of tests for any given product.

Third, the process itself and these several tests should be made by those thoroughly familiar with them, each detail going to an expert.

Fourth, the results should be interpreted in a strictly philosophical spirit, without bias or reference to preconceived hypothesis. This work of interpretation should indeed be open to all connected with the research. Yet because what is everyone's duty is no one's, certain men should be charged directly with this vital task, knowing well that their inferences are subject to review by all their colleagues and will be accepted only as they are just and reasonable.

Each of these four phases of research needs special qualifications: For selection, prophecy and breadth of view; for planning, imagination and administration; for execution, skill and trustworthiness; for interpretation, philosophy.

**Need of Cooperation in Research.**—This mere recitation of the needs of research is a demonstration of the need of cooperation, for it is only a few of the laboratories of the very great industries that have either the various kinds of men with these various gifts, or the means to experiment on so wide a scale. Scattered through the many institutions of learning and the laboratories of the smaller industrial works there are innumerable investigators, each with certain intellectual gifts, each skilled in certain kinds of tests, but few with broad knowledge of the needs of the Government or of any given industry to guide them in their selection; relatively few with the breadth of view needed for wise planning; very few if indeed any with skill in all the different kinds of tests needed; and relatively few endowed with the philosophical spirit needed for intepretation. Yet these men collectively have enormous potencies for research, if their several gifts and skills can be brought into broad cooperation. How often do we see results reached with extraordinary patience and accuracy not utilized but prostituted to support a preconceived hypothesis which, rightly viewed, they discredit?

It is our defect as a race that this sort of team play comes less naturally to us than isolated individualistic research, in which each man obeys his own impulses, and is a law unto himself. But as with men so with nations, development implies first of all the cure of our inborn defects. That the unmitigatedness of our individualism is a defect we are reminded sharply by the present grave threat of our national enslavement by a people far less intelligent, energetic, and self-controlled than we, but as coherent as we are incoherent, as given to team play, as desirous of support, as we are self-reliant and detached. Distasteful as it is to us to act on our motto of "United we stand, divided we fall," if we are to survive our strong units must learn to cohere.

Experience with cooperative research has proved abundantly that, wisely directed, it may stimulate instead of lessen individual initiative, which is of the first importance.

One of the aims of the National Research Council is to induce the cooperative spirit wherever possible in industrial research, and research for the immediate benefit of the Government. The Engineering Division of the Council expects to devote part of its energies to this work, and here it counts confidently on the support of this society. It asks you as individuals and as a body to aid it by pointing out fields in which cooperative research is urgently needed, by advice in planning our researches, by the aid of your industrial and collegiate laboratories in executing the tests, and by your wisdom in discussing the results. It hopes that you will cooperate with it and it with you.

## Organization of Industrial Research

By ARTHUR D. LITTLE,

President, Arthur D. Little, Inc.

**New Aspect of Research Due to War.**—The war, which has changed everything, has given a new aspect to research. Hereafter the nation which would live must know. Through the wreck and peril of other peoples, Americans have learned with them that research has something more to offer than intellectual satisfactions or material prosperity. It has become a destructive as well as a creative agency and in its sinister phase the only weapon with which it may be fought is more research. The organization and intensive prosecution of research has thus become a fundamental and patriotic duty which can neither be ignored nor set aside without imperiling our national existence.

**Research Individualistic and Democratic.**—In considering any plan for the organization of research, one is immediately confronted by the difficulty that science in its highest expression is essentially individualistic and democratic. It resents autocratic control, languishes and becomes sterile under minute oversight and direction from outside. The great advances in human knowledge have almost invariably been due to individual effort set in motion by the scientific imagination and sustained by a consuming desire to ascertain the truth. Pasteur, Curie and Rutherford were not dependent on organization for their results. They worked to the best advantage in proportion as they were free to follow the vision which moved before them. No amount of organization can make a Faraday. It may, perhaps, discover one and is then privileged to provide encouragement, working facilities, and recognition. With these assured it is the part of wisdom to leave him as much alone as possible.

Any really effective plan of research organization must provide for the exceptional man, the man whose angles have not been ground down, who is sometimes not comfortable to rub against, but who has the spark of genius. He is usually a man who hates rules and systems, regular hours, time slips and all the paraphernalia of organization. Organization can help him none the less by relieving him of burdens, making him master of his own time, furnishing equipment, providing organized and immediately available library facilities and by directing his attention to specific problems.

While the superlative work in science, like the superlative work in art, must always be an expression of the genius of the individual and quite beyond the power of organization to ensure, there remains a vast deal of what may be called the secondary work of rounding out the great discoveries and especially of giving them an industrial application which may be rendered most effective only through proper organization. The nimbus which, just at this time, surrounds the word "research" should not blind us to the fact that research involves a great deal of hack work, work for good honest plodders who accumulate the data which permits or confirms the generalization or which is required to give it practical effect.

**The Aims of Research Organization.**—Broadly stated, the aims of research organization should be:

1. To find, develop and train men.

2. To create such a background in the public mind as shall ensure support for research and the industrial utilization of research results.

3. To secure cooperation between different branches of science, as for example between chemists and mathematicians. (The fortuitous combination of the mathematical mind with the viewpoint of the chemist in Willard Gibbs laid the basis for physical chemistry. But such a combination in a single individual is rare.)

4. To avoid the repetition and duplication of effort, first by rendering present knowledge readily available to research workers, second by applying clearing house methods to research projects.

5. To stimulate research by emphasizing the importance of specific problems, making special grants, rendering material and facilities as generally available as possible.

6. To furnish a sort of general staff for research which shall work out the plan of attack for major problems, assign the several lines to competent workers and coordinate and focus the whole.

7. To bring home to manufacturers the advantages

of research with the view of promoting the establishment of private, corporation, and group laboratories.

8. To make and publish a census of available research facilities in men and equipment.

9. To survey the natural resources of the nation and direct research toward their development.

10. To appraise our great industrial wastes and develop plans and methods for turning them to profitable use.

**Committee Organizations and Research.**—There is a nearly universal tendency to attempt the accomplishment of these results through the agency of councils and other forms of committee organizations, the members of which are almost without exception unpaid and involved in other activities which have prior claims upon their time. While such systems of organization may be temporarily efficient and even the only ones immediately available in times of sudden crisis, they do not lend themselves effectively to the slow, constructive work of years without which it is impossible to establish research in its proper place in the industrial and other activities of a nation.

**Research and Technical Schools.**—Any permanent research structure of national dimensions must of course have its foundations in the universities and technical schools. Unfortunately in this time of greatest need these institutions are seriously handicapped by the very generosity of their response to the demands already made upon them. In the scientific departments the instructing staff has been heavily drawn upon for special service and those who remain are carrying a greatly increased burden. Students are distracted by war interests and are constantly being diverted into military activities.

While recognizing the exigencies of the period and applauding the splendid response of American institutions of learning, it may not be ungracious or premature to indicate some of the directions in which these institutions must ultimately move if they are finally to meet the augmenting demands for research and for graduates fitted to cope with industrial research problems.

It is beginning to be recognized that there is no valid distinction between scientific research and industrial research. Both employ the same methods and the same equipment. The demands of either may involve and tax the highest intellectual faculties, and industrial research frequently necessitates that nicety of refinement and sublety of attack which characterizes the highest scientific effort. There remains only the shifting and uncertain line of demarkation which may indeed be found in motive. In the selection of thesis subjects and minor research problems greater prominence may therefore well be given to those having a direct industrial application.

Industry must, however, continue to look to the higher institutions of learning for the determination of fundamental facts and constants, the development of theory and the establishment of general principles. Any adequate response to this demand requires that professors and assistants should have far more time available for research than is now at their disposal. They must have some substantial measure of relief from routine and administrative detail. They should and undoubtedly will have more direct contact with the industries. As a consequence more and more of them will undoubtedly be drawn into industrial positions. This will mean no ultimate disaster to the cause of scientific education provided university authorities recognize the patent fact that the day has come when much larger salaries must be paid and greater distinction accrue to capable men of science who are to continue as professors. With improvement of status the exceptional men will demand greater freedom of decision and action. They will be less bound by academic system and let us hope that as their capacity for research is demonstrated they will resist the influences which would tend to make them mere administrators.

**Science and National Development.**—The expanding recognition of the part which applied science is destined to play in our national development would seem to ensure an adequate supply of scientific students and especially of candidates for degrees in chemistry and chemical engineering. Let us see to it at the start that they are provided with a broader culture than has heretofore obtained in many places, lest they be incapable as scholars of meeting their great responsibilities. Concurrently we must provide means for correcting the recognized deficiencies in their professional training which have been pointed out times without number in the hundreds of papers on the education of the chemist and chemical engineer which have been published during the last few years. Bacon, for example, reports that 70 per cent of the directors of important industrial laboratories express dissatisfaction with the type of instruction which their assistants have received. They find the graduates coming to them ignorant of chemical literature and how to use it, lacking initiative, perspective and sense of proportion, failing in optimism, without knowledge of the simplest industrial equipment. Some of these deficiencies are obviously due to the drying up of inspiration at its source; to the displacement of the quickening influence of master minds by the cut and dried methods of pedagogy. Others, more easy of correction, result from inadequacies of the curriculum itself. It was with the hope of remedying some of the more glaring of these that I made the proposals which led up to the foundation of the School of Chemical Engineering Practice of the Massachusetts Institute of Technology. Recognizing that each process of industrial chemistry may be regarded as nothing more than a coordinated series of unit operations like grinding, roasting, leaching, evaporating, crystallizing and so on, and that knowledge of these unit operations postulates the ability to combine them as required, the school established a number of stations at large industrial plants selected for the variety of unit operations carried out within them. Groups of third-year students passed in turn through each of the stations, studying practice and illustrating theory in the plants themselves. The reaction of the course upon the students went beyond all expectations and it is one of the minor disasters of the war that the school was obliged to suspend by the requisition of its teachers and the diversion of its students into war activities.

**Must Organize Research with Means and Men at Hand.**—We must, however, organize our research with the means and men at hand and look hopefully to the future for accessions of human material of higher average training and far broader scholarship.

Since the frontier of knowledge is the starting point of research the energy of the explorer must be conserved on his way to the frontier. In no way, therefore, can organized cooperation render more effective service to research than by making readily accessible those vast stores of specialized knowledge which research has already accumulated but which still require to be brought into that systematized and orderly arrangement which characterizes science. The research laboratory should be built around a library. These special libraries should be linked together and closely affiliated with the great libraries of the world. Such admirable journals as Chemical Abstracts should be substantially endowed, the publication of monographs encouraged and assisted, while systematic reviews and reports of progress covering limited special fields in science and technology should appear far more frequently. The intensive collection of scientific and technical information throughout the world, its codification and its distribution, might well be made a governmental function to an extent not now approached.

**Principles of General Application in Industrial Research Laboratories.**—Experience has shown that in the organization and conduct of industrial research laboratories certain well-established principles are of general application.

It is desirable that the laboratory be separately housed and that an institutional atmosphere be developed and maintained. It should be recognized that research is necessarily expensive and that results are not forthcoming over night. The ovulation of ideas takes time and their material embodiment proceeds slowly and seldom can be hastened without danger. Adequate equipment, which is often costly, is essential for good work and a liberal policy must be followed where requisitions are concerned. It is well to have the laboratory expenditure arranged on the appropriation system and to allow the director a free hand within the appropriation. If the laboratory is a part of an industrial organization it should maintain close contact through conferences and reports with all departments of the organization; but no department should be allowed to dominate the laboratory, and its director should be responsible only to the executive of the corporation. Since no organization can include every department of human knowledge the director should be encouraged to make frequent use of the advice and services of outside specialists.

It is well in case of major problems to start somewhere as well as may be, even though the starting ground be not wholly to one's liking. It is easily possible to spend too much time in preliminary searches of the literature, and better to avail of early enthusiasms in some initial work at least while carrying on concurrently the tedious task of reviewing and abstracting literature.

Nothing is more expensive or demoralizing than experimentation in the plant. An industrial research laboratory should, therefore, be adequately provided with equipment of semi-commercial size. Infant mortality among processes is high in any case and the most critical period in their young lives is that covering the transition from the laboratory to the plant. They require and the research laboratory should provide a nursery to protect and foster them during this period of their development. Some large manufacturers have even found it desirable to operate in connection with and under the sole direction of their research laboratory a small plant in which actual commercial manufacture is regularly conducted. Such extension of the laboratory's function permits the complete reduction to practice of new methods and the commercial demonstration of the sufficiency of the product before the innovations are introduced into the main plant.

Even when no such provision appears feasible it is, nevertheless, highly desirable to have the industrial research laboratory actually engaged in some small scale, highly specialized, commercial manufacture, preferably of some product which it has itself originated. The least advantage of this procedure is that such manufacture of a properly selected product may frequently defray a substantial proportion of the expenses of the laboratory. The major benefits are the acquirement of a certain commercial sense by the laboratory staff, an appreciation of the conditions and difficulties of actual production, and finally the strengthening of the position of the laboratory through the increase in its turn-over and equipment. Such procedure, while perhaps not general, has been followed to great advantage by the research laboratories of the General Electric Co., the Eastman Kodak Co. and Arthur D. Little, Inc.

**Personal Factor Determines Performance in Research.**—As regards any research laboratory, it goes without saying that it is the personal factor which determines performance and this is preeminently true of the laboratory director. Sir Humphrey Davy truly said that his greatest discovery was Michael Faraday, and no greater problem is likely to confront a research laboratory than that involved in the discovery of a director. Successful laboratory directors may be of several types, but a militant optimism, contagious enthusiasm, controlled imagination and quick human sympathy are common to them all. Such a man will naturally in selecting his subordinates look for these personal qualities almost as carefully as he will weigh specialized scientific training, and having been thus guided in his selections will find it relatively easy to inspire throughout his organization those relations of good fellowship and that esprit de corps which multiply enormously the effectiveness of any working force.

Exceptional men are hard to find simply because they are exceptional, and the director in laying out the work of the laboratory and extending its personnel will endeavor to augment the output of the exceptional man through the coordinated effort of properly directed men of secondary capacity.

Fairness in apportioning credit, frequent conferences, and opportunity for self-development are essential to the attainment of high efficiency.

Among laboratories thus constituted and directed, cooperation should not be difficult and is, in fact, already frequent. The real need of the situation is cooperation among manufacturers for the support of research. The long first steps in this direction have already been taken in Great Britain by the Advisory Council for Scientific and Industrial Research. In our own country the National Canners' Association has been signally successful in applying to research the principle of cooperation. We shall tonight, most fortunately, be authoritatively informed regarding each of these developments. Stimulating and encouraging as they are, we must, nevertheless, regard them only as surface indications of the great wealth of opportunity which lies below. There is hardly a trade association in the United States which might not to the great advantage and profit of its members address itself to the solution of common problems by similar means.

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**Chinese Yards to Build Ships for United States.**—Chairman Hurley of the Shipping Board has awarded a contract for the construction of 120,000 tons of steel ships in the Chinese Government yards at Shanghai.

# The Engineer and the War*

By M. E. COOLEY,

Dean of the College of Engineering, University of Michigan

When the great European war started, in 1914, among the very first to volunteer their services were the college-trained men of England and France. This was but natural, as, because of their training, they could quicker grasp the war's significance. As England's great and immediate need was an army, and as college men could more speedily absorb the necessary training, they were accepted, and large numbers of them, among the first hundred thousand, went forth to their first duty, the protection of their homes, and found their Hall of Fame on the battlefields of France and Belgium.

As England roused herself to the war and realized that her only course was to see it through, she called back home those of her technically trained men who were left after those early days and began the construction of her present great military and naval plants, without which she could not hope to conduct a successful war. What failure meant to the civilized world, our part of it in particular, is only beginning to be realized.

That it was to be a war of science and machinery was made clear to the world by the fact that for 40 years Germany had, besides making soldiers out of her citizens, been calling on her men of science for new ways to increase the horrors of warfare, and on her great manufacturing plants to make ready the structure and machinery. And as the ideas of scientists are made applicable to the problems of peaceful life by the engineer, so must he also make them applicable to the problems of war. Thus the engineer finds himself in vital positions engaged in creating and developing the resources of war, in transporting them to the front, and there building the works necessary for their utilization most effectively.

The world scarcely realizes the extent to which it is dependent on the scientist and engineer for the conveniences and comforts of life—nay, more, even the pleasures of life—in this wonderful mechanical age. The tales of the Arabian Nights pale in comparison. The segregation of the engineer, slow in the beginning, gained but slight headway before his advent as a college-trained man. Even then it required years to establish his professional entity, so much is he a part of the things which make up our daily lives—our own entity. But a curious thing happened. The nineteenth century went to sleep with the engineer still a child—an orphan, as it were—seeking an opportunity to be of some use in the world; in other words, seeking a job. When the twentieth century awoke the tale was reversed; the job went seeking the engineer. In the years just prior to the war the demand for graduates was far in excess of the supply; but now, with war increasing many fold the output of our factories and straining to the breaking point our transportation systems, the number falls far short even of barest necessities. All those who were able have gone into the fighting machine itself, still further depleting the ranks of engineers; and the ranks of scientists, too, have in the same way been depleted.

The conditions in this country with respect to its supply of engineers has been set forth by the U. S. Bureau of Education in its Circular No. 4, Aug. 30, 1917, from which I quote:

The Engineer Corps [illegible] ,000 engineer officers [illegible]

[illegible]

[illegible]

| | |
|---|---|
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| Total | [illegible] |

[illegible]

[illegible]

| | |
|---|---|
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] specified | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| Total | [illegible] |

[illegible]

| | |
|---|---|
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| Other types of [illegible] | [illegible] |
| Total | [illegible] |

The [illegible] with [illegible] paralleled in several other technical callings. It is this fact which has induced statemen, educators, scientific associations and industrial leaders to urge repeatedly and emphatically that the higher institutions of the country, and particularly those which give technical or scientific training, be kept in full operation, and that young men everywhere be encouraged to attend them. Such [illegible]

## Lehigh University to Start Course in Ship Construction

To supply trained men for present demands in ship building and operation and for future demands in ocean transportation and foreign commerce, Lehigh University will inaugurate in September a three-year course in Ship Construction and Marine Transportation. It will have the same entrance requirements and the same basis of mathematics and sciences as the other engineering courses. In the second year this course will present strength of materials, machine design, metallurgy and steam engineering and also economics and business law. The work of the final year will be given under the three divisions of naval architecture, marine engineering and foreign commerce. Naval architecture includes studies in the design and construction of wooden, steel and concrete ships. Under the marine engineering is embraced steam engineering, marine engines and marine steam turbines. To prepare them for international trade, students will be instructed in accounting, banking, foreign commerce, foreign exchange and marine insurance. The summer work in the course will be given in ship yards of the Atlantic Coast. The term at Lehigh will open on Sept. 12.

**Fifty-six Per Cent of Structural Shop Capacity Contracted For.**—The records of the Bridge Builders & Structural Society, as collected by its secretary, show that during the month of June, 1918, 56 per cent of the enitre capacity of the bridge and structural shops of the country was contracted for.

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*From the Michigan Technic.

# Dean Richards Advises Drafting High School Graduates to Fill Engineering Colleges

Drafting high school graduates to fill the depleted classes in technical colleges is suggested by Prof. C. R. Richards, Dean of the College of Engineering of the University of Illinois, in a letter sent recently to the Secretary of War. In his letter Prof. Richards suggests that the requirements for enlistment of engineering students be revised so that students may be permitted to enlist and remain at college until they graduate. He also recommends that a student who has completed 2 years' work in a technical school, who already has been enlisted or drafted, be returned to college on detached duty until he graduates.

The letter follows:

I have been very greatly concerned over the ever increasing demands of the Army, the Navy, the various government bureaus and the industries for men of technical and scientific training, since with the increasing demand for such men there is a decrease in the supply. Thus, the College of Engineering of the University of Illinois has for a number of years graduated over 200 persons a year, not including those completing the curriculums in chemistry and in chemical engineering. This year we shall graduate only 121 persons from the College of Engineering, and from present indications the number of graduates next year will be still smaller.

During recent years there has been a growing appreciation of the importance of technical and scientific training by men who are engaged in industrial work, but never before has the importance of such training been so evident as at this time, when the need is so great to solve a variety of new problems quickly. It does not take a very long time to make an effective soldier from a man without previous military training and experience, but it does require a very considerable amount of time to train a man for expert scientific and engineering service. It seems to me, therefore, that the Government should exercise increasing care in the selection of men for the Army, to avoid the drafting of highly trained experts for service which can be performed almost as well by men who have had little educational preparation.

As a result of my observations of the conditions which are affecting the training of men for service in technical and scientific lines, I feel justified in presenting for your consideration the following:

1. I recommend that the requirements for the enlistment of students in the enlisted reserve corps of the engineering department, as formulated by the Chief of Engineers under date of Dec. 15, 1917, be revised so that any student who is a citizen of the United States and who is doing acceptable work may be permitted to enlist and to remain in college until he graduates, or until he shows inability or unwillingness to do satisfactory work. The present requirements for the enlistment of engineering students are so exacting that relatively few men can qualify. Many men whom we would be willing to certify as showing great promise are at present ineligible. As a consequence, I feel that the cumulative effect which would otherwise have been experienced from the privileges granted under these regulations has been seriously reduced.

2. I suggest that students who are enlisted in the engineer reserve corps be regarded as on detached duty in the active service of the Government, that they be required to wear the regular uniform, and that they receive some stipend during the time that they remain in service to keep them. If they were paid $30 a month the total annual expenditures would be slight in comparison with other expenditures which the Government is compelled to make in the conduct of the war. The psychological effect of this plan on the students and the public would be of enormous value, and it would greatly assist in maintaining a reasonable supply of men in training for technical service.

3. In my judgment, students in technical and scientific schools should not be permitted to enlist or be drafted unless it can be shown that they will not profit by the instruction given. They should be enlisted for instruction until they graduate. I recommend that every intelligent student who has completed two years' work in a technical or scientific school who has already been enlisted or drafted be returned to college or detached on duty until he graduates.

4. Many sentimental and misguided persons consider that a young man who fails to pass for active Army or Navy service is a "slacker," even though his training and experience render him more useful in scientific work than in the fighting branches of the service. It seems to me that every effort should be made to correct this impression.

5. If the conditions under discussion become more serious, as is likely to be the case, I recommend that approximately 2 per cent of the boys graduating from the high schools be drafted for service as students in the technical schools of the country. This plan will be a part of compulsory education which may be fully justified on the score of national necessity.

6. Since all the preparations for war involve a great variety of educational processes, and since the technical and scientific colleges should be maintained at the highest rate of efficiency, it is important that some provision be made at once to prevent the loss of teachers from these colleges. It requires a peculiar combination of qualifications to make a successful teacher of engineering or science. The drafting of such men is a serious mistake. If there is no other way to protect the successful teacher, the value of his services should be recognized by permitting him to enlist in some branch of the Army and be placed on detached duty or on the inactive list in the institution at which he serves.

# Asphalt Mastic Shop Floor in Good Condition After 6 Years Use

In 1912 an asphalt mastic floor was constructed at the forge and structural shop of the Twin City Rapid Transit Co., Minneapolis, Minn. The floor consisted of a 1½-in. layer composed of 65 per cent gravel, rock and bank sand and 35 per cent mastic and flux, laid on a concrete base. The editors of the Electric Railway Journal recently addressed an inquiry to W. J. Smith, master mechanic of the company, for the purpose of learning how satisfactory the floor had proved. The information obtained is printed in a recent issue of the above mentioned journal, from which the following matter is abstracted:

In reply to the inquiry Mr. Smith states that the floor has given excellent satisfaction. It has had hard service but no repairs have been necessary and it is in first-class condition today with the one exception that it is somewhat marked up where the pieces of heavy material have been piled or where jack screws and heavily loaded horses have stood. Sometimes from 20 to 30 tons of steel have been piled in a small space and the weight of this material caused the bars and sections to mark up the floor, especially in warm weather. However, this has never caused any great trouble, although it somewhat mars the appearance of the floor. Where the floor has not been subject to this heavy piling it is smooth and free from cracks and in fine condition.

Experience has shown that when a floor of this kind is laid it is very important to have firm ground or if it is to be laid on a reinforced concrete slab to have this in good condition. This mastic asphalt floor is made of the same material and is laid in practically the same way as paving asphalt, with the possible exception that a larger proportion of finely crushed rock is mixed with the asphalt. The company uses the same material on the back platforms of all passenger cars. When first used there was some trouble with the floor becoming soft in warm weather, but this difficulty was overcome by using a larger proportion of finely crushed rock. As much of this fine rock was used as could be worked into the mixture without preventing the possibility of troweling it out. It is important to use a flux to coat the concrete. Any contractor familiar with putting down asphalt pavement could do a satisfactory job on floor work. The more service the floor gets the better it appears to be, as it gradually becomes smooth and firm but never hard and slippery.

## Emergency Building Work of the War Department

Emergency work to house and provide for the wants of soldiers in this country and to provide buildings for the manufacture and storage of supplies for the Army, both here and abroad, undertaken by the construction division of the Army, which has been executed, or is under way and in prospect up to June 1, will, it is estimated, cost $1,170,619,040. This total does not include three operations, costing $106,000,000, which are being conducted under the direct control of the Ordnance Department.

All work done under the direction of the construction division is performed under the emergency construction contract, which is based on the cost of the work plus a percentage with an established maximum fee. By this contract no contractor can receive a fee of more than a quarter of a million dollars, no matter how great the total cost of the operation may be.

Up to June 1 the division had completed 53 jobs at a total cost of $202,250,000. It now has 244 operations under way, which when finished will cost approximately $270,369,040. Preparations are being made to start work on 117 new operations which are expected to cost $700,000,000.

Of the finished jobs, 36 were at cantonments and camps. The total cost for National Army cantonments was $140,726,473. General contractors' fees were $4,000,000, or 2.84 per cent of the total. From this amount the contractors had to meet all their overhead expenses of organization. The National Guard camps cost $38,375,272, on which the Government paid fees amounting to $2,636,534, or 6.98 per cent of the total. In every case the contractors were compelled to meet the expense of maintaining their organization from the fees collected from the Government.

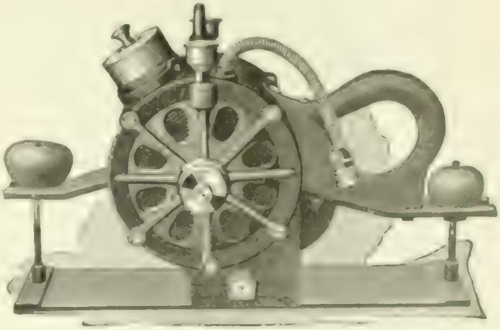
Some of the operations in prospect are: Storage terminals at Boston, Philadelphia, Charleston, S. C., and 28 other points; Signal Corps cantonments and aviation fields; powder loading plants in suitable places, and ordnance depots on the Atlantic Coast; housing for the Shipping Board at 16 points; quartermaster warehouses at Columbus, Ohio, Albany, N. Y., Middletown, Pa., and Buffalo, N. Y., and other points; aviation camps at 40 points; ordnance storage depots at several points; a remount station at Charleston, S. C.; mechanical repair shops for troops of the Regular Army in Texas; three office buildings in Washington in addition to those already under way; a hospital at Fort Riley, Kans.; an isolation hospital at Tenafly, N. J.; extensions at Springfield Arsenal, and gas-making plants and gas shell filling plants at other points.

The Construction Division of the Army, which is the outgrowth of the Cantonment Division, is now in charge of Col. Richard C. Marshall, Jr., and is composed of about 5,000 persons. Approximately 700 officers are engaged. The majority of the latter are men from civil life experienced in constructive work.

**Thawing Frozen Ground with Water Heated by Live Steam.**—In the construction of the Maywood plant of the American Can Co. the holes for the footings were thawed out by filling them with water and then heating the water with live steam. The tops of the footings when concreted were kept reasonably warm by a covering of 12 in. to 15 in. of straw.

## Labor-Saving Power-Operated Planer

A portable electric planer, operated like an ordinary carpenter jack plane, and stated to be capable of planing from 500 to 700 sq. ft. per 8-hour day, with one man, has been placed on the market recently. The planing is done by rotary cutting blades (making about 3,600 r.p.m.) operated by a small light motor directly attached to the machine. Each forward movement of the planer produces a smooth surface up to 4 in. wide. Flat or curved surfaces are planed with equal ease, since the base is adjustable to conform to the surface worked upon. The planer was devised by Capt. F. L. Forward while engaged on a contract for constructing 110 ft. submarine chasers for the Government. A test on this contract showed that it took 15 men at $4 per day, 12 days to plane the sides of one of the 110 ft. chasers by means of the ordinary jack plane. The same work was done in 4 days by two men with the power planer at a total cost of $48 including power. This planer is manufactured by the Universal Planer Co., Inc., 16 Exchange Place, New York City.



Power Operated Planer

## Edgar Marburg

Dr. Edgar Marburg, whose death June 27 was briefly noted in our July 3 issue, was graduated from Rensselaer Polytechnic Institute in 1885. Previous to his appointment to the Professorship of Civil Engineering at the University of Pennsylvania in 1892, a position he held until his death, he was employed in the engineering departments of the Keystone Bridge Co., the Phoenix Bridge Co., the Edge Moor Iron Co. and the Carnegie Steel Co. When the American Society for Testing Materials was organized in March, 1902, Prof. Marburg became its secretary-treasurer. The success of the society is largely attributable to his efforts. Prof. Marburg's death occurred during the session of the last annual convention of the society. The following resolution, prepared by Past Presidents Arthur N. Talbot, A. A. Stevenson and Henry M. Howe was adopted by rising vote:

[illegible]

ing. He is honored and revered as a master and leader. The imprint of his work will long remain

The society extends to the family heartfelt sympathy for their great loss. May the knowledge that his fine character, strong manhood, and great work in the field of engineering are appreciated by the membership of the American Society for Testing Materials become a part of their many treasured memories of his life and work.

**Contracts Let for 61 Vessels.**—During the week ending July 13 contracts for 61 vessels, representing 439,800 dead-weight tons, were let by the United States Shipping Board and Emergency Fleet Corporation. Of this tonnage 392,800 will go into steel construction, the rest into wooden ships. To the Skinner & Eddy Corporation, of Seattle, went a contract for the building of 35 steel cargo steamships of a dead-weight tonnage of 332,800. The Mobile Shipbuilding Co., of Mobile, Ala., received a contract to build 12 steel freighters of a combined tonnage of 60,000, making 47 of the steel type provided for in the new contracts. Contracts for building 14 wooden ships were divided between K. M. Murdock, of Jacksonville, Fla., who will construct 6 of this type, with a total tonnage of 21,000. The Missouri Valley Bridge & Iron Co., of Quantico, Va., which will build 7 of an aggregate tonnage of 24,500, and the Continental Shipbuilding Corporation, of Yonkers, N. Y., which was given a contract for building 1 vessel of 1,500 tons.

**67 Wooden Ships Completed Up to June 1.**—A total of 67 wood ships with an aggregate tonnage of 242,200 was added to America's merchant marine up to June 1, according to figures prepared by the Division of Wood Ship Construction. Twenty-two of these are of the Hough type, 28 Ferris, 16 of the Emergency Fleet Corporation's own design and 1 of the McCormick type. The majority of the ships are 3,500 tons each. The largest was a 4,700-tonner, the Bonham, built by the National Shipbuilding Co. at Orange, Tex. The tonnage totals by months are as follows: December, 7,500; February, 18,500; March, 40,000; April, 60,500, and May, 115,700.

## Personals

George H. Schwan has been appointed secretary of the recently established Bureau of City Housing of Pittsburgh, Pa.

George M. Brill has been made head of the newly created requirements section to handle shipyards supplies for the U. S. Shipping Board.

W. N. McDonald, head of the contracting firm of McDonald & Co., Jacksonville, Fla., has been given a commission as captain in the U. S. Engineers.

W. J. Elmendorf, of Campbell, Wells & Elmendorf, mining engineers, 114 James St., Seattle, Wash., has been appointed consulting engineer for the United States Bureau of Mines. His jurisdiction will be in the Northwest.

J. H. Kirby of Houston, Tex., has been appointed lumber administrator of the Emergency Fleet Corporation to administer all activities of the shipbuilding program connected with the production and storage of lumber. Mr. Kirby will also assume control over all logging operations.

John M. Goodell has been appointed consulting engineer of the U. S. Office of Public Roads and Rural Engineering. Mr. Goodell for some months at the beginning of the war assisted in the organization of the work of the Committee on Public Information. For the past 6 months he has been assisting the personnel division of the U. S. Shipping Board.

Arthur H. Young, director of the American Museum of Safety since Jan. 1, 1917, has resigned to take charge of the Employe Relations Department of the International Harvester Co. He is succeeded by R. M. Little, formerly chairman U. S. Employes' Compensation Commission. Chester C. Rausch, heretofore Chief Safety Engineer of the Navy Department, Bureau of Docks and Yards, has been appointed assistant to the director.

Colonel Frank E. Walters, of Toledo, O., has been appointed by the War Department as a member of the special board of ordnance experts to have charge of the new Neville Island gun and projectile plant to be built by the United States Steel Corporation in co-operation with the Government. Colonel Walters received his commission in the ordnance department in February. He was formerly with Mills, Rhines, Bellman & Nordhoff, architects, and later with the building department of the Willys-Overland.

Charles Brossman, consulting engineer, of Indianapolis, Ind., and Frank C. Wagner, professor of mechanical engineering at Rose Polytechnic Institute, Terre Haute, have been appointed by the United States Fuel Administration to take charge of special fuel conservation activities in Indiana. Mr. Brossman's duties will be limited to investigation of electric power plants in the state for the purpose of making recommendations for the consolidation of certain plants in order to save fuel. Professor Wagner is appointed as administrative engineer for Indiana. His duties will be to seek means of increasing the efficiency in fuel consumption.

Appointments as follows have been announced by Arthur W. Thompson, federal manager for the railroads in the Allegheny region: R. N. Begien, operating assistant to the federal manager, formerly general manager of the Baltimore & Ohio; J. M. Davis, formerly president in charge of operations of the Baltimore & Ohio, made manager of the Baltimore & Ohio, New York Terminal; S. Ennes, formerly general manager of the Western Maryland Ry., made general manager of the Baltimore & Ohio eastern lines and the coal and coke railway; Maxwell C. Byers, formerly assistant to the president of the Western Maryland Ry., made general manager of the Western Md. Ry., Cumberland Valley R. R. and Cumberland & Pennsylvania R. R.

The following architects, town planners and engineers have been selected for the housing developments to be undertaken by the Government under the act recently passed by Congress appropriating $60,000,000 for the construction or lease of quarters for the war workers: Project No. 10, Erie, Pa.—Architect, Albert H. Spahr, Pittsburgh; town planner, C. D. Lay, 15 E. 40th St., New York City; engineer, Chester & Fleming, Pittsburgh. Project No. 18, South Charleston, W. Va.—Architect, Godley, Haskell & Sedgwick, 244 Madison Ave.; town planner, James L. Greenleaf, 1 Broadway, New York; engineer, James L. Greenleaf. Project No. 24, Bethlehem, Pa.—Architect, Zantzinger, Borie & Medary, 112 S. 16th St., Philadelphia, Pa.; town planner, T. W. Sears, 1424 Walnut St., Philadelphia, Pa.; engineer, L. J. H. Grossart, Bethlehem Steel Co., Bethlehem, Pa. Project No. 27 a. b. Washington Navy Yard—Architect, York & Sawyer, 50 E. 41st St., New York City. Project No. 27 c. Washington Navy Yard—Architect (temporary), James A. Wetmore, acting supervising architect's office, Washington, D. C. Project No. 54 a. b. c. Washington Dormitories—Architect, Waddy B. Wood, 816 Connecticut Ave., Washington, D. C. Project No. 59, Bath, Me.—Architect, Parker, Thomas & Rice, 110 State St., Boston Mass.; town planner, Lorring Underwood, 16 Exchange St., Boston, Mass.; engineer, Weston & Sampson, 14 Beacon St., Boston, Mass. Project No. 62, Quincy, Mass.—Architect, J. E. McLaughlin, 88 Tremont St., Boston, Mass.; town planner, H. J. Kellaway, 12 West St., Boston, Mass.; engineer, Ernest W. Branch, 21 Adams Boulevard, Quincy, Mass. Project No. 102, Bridgeport, Conn.—Architect, R. C. Sturgis, 120 Boylston St., Boston, Mass.; town planner, A. A. Shurtleff, 69 State St., Boston, Mass. Project No. 141, Puget Sound, Wn. (Bremerton).—Architect, A. H. Albertson, 725 Henry Bldg., 394 Jackson St., Portland, Ore.; engineer, Sawyer Bros., 410 Lindelle Bldg., Spokane, Wn.; Geo. B. Sawyer, of Sawyer Bros., 407 White Bldg., Seattle, Wn. Project No. 150 a. b. Norfolk and Portsmouth.—Architect, George B. Post & Sons, 101 Park Ave., New York; town planner, none; engineer, Nicholas Hill, 100 William St., New York. Project No. 150 c. Norfolk and Portsmouth (colored).—Architect, Russell Edw. Mitchell. Project No. 378, Watertown, N. Y.—Architect, Davis, McGrath & Kiessling, 175 5th Ave., New York; town planner, F. Vitale, 527 5th Ave., New York; engineer, E. W. Sales, city engineer, Watertown, N. Y. Project No. 502, Philadelphia Navy Yard.—Architect, Rankin, Kellogg & Crane, 1012 Walnut St., Philadelphia. Project No. 581, Mare Island (Vallejo), Cal.—Architect, George W. Kelham, Sharon Bldg., San Francisco, Cal.; town planner, F. R. Jones, care of G. W. Kelham, San Francisco, Cal.; engineer, S. E. Kieffer, Mechanics Institute Bldg., San Francisco, Cal. Alliance, Ohio.—Architect, Walker & Weeks, Cleveland; town planner, De Forrest, Rochester.

## Obituaries

William Burge, a retired contractor of Toledo, O., died June 24 in Los Angeles, Cal.

Thomas Paterson, a pioneer contractor of Kalamazoo, Mich., died last week, aged 90 years.

Levi E. Mullen, 65, architect, builder and contractor of Columbus Grove, O., died suddenly last week.

Frederick Hart, of the firm of Brubaker & Hart, bridge builders, a resident of Mount Nebo, died July 4 at a hospital in Lancaster, Pa., aged 54.

Major General George Whitfield Davis, retired, died July 12. General Davis was assistant engineer in completing the Washington monument and also took an active part in the early work of building the Panama canal.

Robert S. Armstrong of New York, fabricating engineer for the Carolina Shipbuilding Corporation, Wilmington, N. C., died July 15th. Death was due to apoplexy. Mr. Armstrong was for 10 years fabricating engineer for the American Bridge Co., and later general manager of the Downey Shipbuilding Co.

Edwin H. Sandison, founder of Everest, Horton and Liberal, Kan., died July 2 at his home in Los Angeles, Cal. He settled in Everest in 1881, when the Missouri Pacific was building through that section. Thirty years later, when the Rock Island built from St. Joseph to Topeka, his firm founded Horton.

Mr. Edward S. Meloy, Assistant Engineer in charge of bridge inspection and bridge construction for the Chicago, Milwaukee & St. Paul Ry., died July 8 at his home in Chicago. He entered the service of the C., M. & St. P. Ry., in 1886 as draftsman, and in 1890 was promoted to Assistant Engineer. He was in continuous service up to a short time before his death.

## Industrial Notes

The All-American Truck Co. of Chicago has been organized with R. H. Spear as president. The principles of the company are indicated by its title: Only American citizens are employed in its factory; only parts made in America are used in the manufacture of its trucks; the entire sales organization is composed solely of American representatives, distributors, dealers and salesmen.

*British Engineering Review Issue*

# ENGINEERING AND CONTRACTING

HALBERT P. GILLETTE, *President and Editor.* [illegible], *Vice President and General Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year, but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering field. See advertising page for further information and [illegible]

**Roads and Streets—1st Wednesday**
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies

**Waterworks and Hydraulics—2nd Wednesday**
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power

**Railways and Govt. Works—3rd Wednesday**
(a) [illegible] (c) [illegible]
(b) [illegible]

**Buildings and Structures—4th Wednesday**
(a) [illegible] (c) [illegible]
(b) Bridges (d) [illegible]

Volume L. CHICAGO, ILL., JULY 31, 1918 Number 5

## Our British Engineering Review Issue

The articles in this issue of Engineering and Contracting relate entirely to British design and construction in the civil engineering field. The material for these articles has been selected and condensed for us by Prof. Alexander Haring of New York University.

We believe our readers will agree with us that the 50 articles in this issue constitute a very interesting and instructive review of recent British practice, and that this issue forms an excellent companion to our French Engineering Review issue of May 29.

If French engineers are ingenious, English engineers are not less so. We American engineers are justly proud of our own engineering achievements, but we should not let our national pride deter us from studying carefully the engineering works of other nations. Relatively few American civil engineers and contractors have access to foreign engineering periodicals. Hence our decision to publish three large special issues annually, giving comprehensive summaries of the most useful information to be found in foreign civil engineering periodicals and society transactions. Our next special foreign issue will be Oct. 30.

Every subscriber for a monthly issue of Engineering and Contracting, as well as every weekly subscriber, will receive our three foreign special issues and our annual New Equipment Issue without extra charge, these four special quarterly issues being included in the subscription price.

## British, French and Americans as Leaders in Engineering and Inventing

In a recent article that has been widely quoted it was shown that the great majority of chemical discoveries of a fundamental nature were not German. We purpose showing briefly that of the four leading scientific nations of the world, Germany has to its credit fewer inventions that any one of the remaining three.

In the Encyclopedia Americana there is a table giving important inventions and scientific discoveries made during the period of 1560 to 1903. We have analyzed the table with the following results:

| | |
|---|---|
| [illegible] | [illegible] |
| British | [illegible] |
| French | [illegible] |
| German [illegible] | [illegible] |
| Total | [illegible] |
| Italian | [illegible] |
| [illegible] | [illegible] |
| Austrian | [illegible] |
| Russian | [illegible] |
| Swedish | [illegible] |
| Danish | [illegible] |
| Grand total | [illegible] |

Although America is credited with only three inventions prior to its becoming independent in 1776, it heads the list, with England a close second. These two English-speaking nations between them have to their credit 70 per cent, and America alone has 40 per cent of the notable inventions and scientific discoveries given in the table. The table is not complete nor is it up to date, but it gives a fair index of the relative inventive productivity of the 10 nations above listed.

Let us now review briefly the world's indebtedness to Great Britain and to America. The two most important inventions in the entire list under discussion are the steam engine and the steam railway, and these are both British. The first steamboat was English, but an American was the first to make a completely practical and economic steamship. Similarly in the Crimean war the English used the first armor-clad boat, but it was reserved for Americans to develop the first armor-clad steamships, the celebrated Monitor and Merrimac.

The first "steam road-wagon" was made in 1787 by Oliver Evans, an American; and about a century later the first automobile propelled by gasoline was made by another American. So the gasoline motor car and truck owe their origin to America, as an offset to the English locomotive and railway. The first practical gas engine was invented in 1860 by Lenoir of France. The first flanged wheel for railway use was

British, but the first T-rail spiked to cross-ties was devised in 1830 by Robert L. Stevens, an American. And it was also an American engineer who invented the Howe truss bridge, the forefather of all modern truss bridges.

Without the steel rail, modern railways could not exist. An American, as we have just said, designed the form of the modern steel rail; but an Englishman, Bessemer, was the first to make cheap steel on a large scale. However, Bessemer's air blast method of steel making was antedated 8 years by Kelly, a Pennsylvania iron manufacturer, and Bessemer was unable to secure a patent in this country.

An Englishman made the first practical traction engine, but an American devised the caterpillar wheels that enable a tractor to travel over any kind of soil. Without these "track-laying wheels" it would have been impracticable for an Englishman to produce the "tank," that warship of the sand and mud.

Seventy years ago an English engineer, Thompson, invented the pneumatic tire; but, to make it practicable, the American, Goodyear, had to invent a process of vulcanizing rubber. All the automobile and trucking world therefore owes an enormous debt to those two men, not to mention the debt that all rubber users owe to the indomitable Goodyear. It we remember correctly, Goodyear worked for 17 years to solve the problem of making rubber fit for industrial use, and in his final successful experiment burned up the kitchen table and chairs. It is men of just that sort of never-give-up grit who are among our engineers in France today.

Without railways and steamboats modern war, as well as modern industry, would be impossible. The same holds true as to hard roads. Tresaguet, the Frenchman, taught Tredgold, the Englishman, how to build economic hard roads of broken stone; but Macadam, the Scotchman, "went both of them one better." Macadam taught the world that broken stone needed no other foundation than a well-drained soil. That was a notable advance in road building, but it was reserved for the American, Blake, to make it possible to build broken stone roads cheaply with high priced labor. He invented the first rock crusher, without which macadam and concrete would be almost prohibitively expensive in this country, to say nothing of the added cost of milling all ores.

Nobel, of Sweden, invented dynamite, but the Americans, Couch, Fowle and Burleigh, made the power rock-drill. The steam-shovel was an English invention, but the world owes to America the following earth-excavating machine: Wheelscraper, fresno scraper, power scraper, elevating grader, road grader, dump-wagons, hydraulic giant, hydraulic dredge, trench excavator, etc.

The steam-hammer, used in pile-driving, in forging, etc., etc., is English. So is the steam-pump. First used in Cornish mines, the steam-pump has come to have countless uses. The steam road roller is claimed both by the English and the French.

It was Murdock who invented gas lighting in England in 1792. Our Edison made incandescent electric lighting practicable, but we owe the arc light to an Englishman. And this brings us fairly into the midst of electricity.

Sturgeon made the electromagnet and Faraday made the dynamos, both English inventors of inestimable importance, but the world owes to two Americans, Morse and Bell, the use of the electromagnet for sending messages by telegraph and telephone.

If we look to England for the first steam railway we must look to America for the first successful electric railway. Ours is the trolley car and the whole evolution of electric transportation.

Edmund Halley of England made the first practical diving bell, but the first practical submarine was American. A Frenchman made the first balloon, but our Wright brothers were the first men to fly instead of "float" in the air.

Photography, first developed by the English and French, became moving photography when Edison invented his kinetoscope. How old that name already sounds in these days of the "movies." The English, we fear, have no counterpart for our phonograph, also the invention of Edison.

Meikle, of England, made the first grain thresher in 1788, and he was followed by many other English inventors of agricultural machinery; but our American inventors have long been leaders in this line. Between the British and the Americans almost all inventions of agricultural machinery have been monopolized. Similarly with printing presses, linotype machines, typewriters and calculating machines. Here neither the French nor the Germans make much of a showing as inventors.

In textile machinery the British were also pioneers, but Americans invented the cotton-gin, the sewing machine and almost all the shoe-making machinery.

An Englishman invented portland cement, a Frenchman patented concrete, and the invention of reinforced concrete is claimed both by the French and the Americans; but the other day an American engineer built the first great sea-going concrete ship. Americans were pioneers in reinforced concrete buildings, and in steel-frame buildings. American engineers also invented the elevators that make our sky-scrapers practicable.

In the foregoing list we have named most of the leading mechanical and electrical inventions, and it is seen that the English-speaking nations have the vast majority of such inventions to their credit. How is it with the tools and engines of war?

The Chinese are said to have invented gunpowder. Who made the first gun is unknown, but nearly all the fundamental inventions relating to modern rifles and guns are English and American. To the Americans belong the following: The revolver by Colt (1836); the magazine gun by Hunt (1849); the machine gun by Gatling (1861); the torpedo by Whitehead (1866). To the British belong: The percussion cap by Forsyth (1807); the built-up cannon (1855) and the first practical breach-loading cannon by Armstrong: the disappearing gun carriage by Moncrief (1868); and the improved machine gun by Maxim (1884). Aside from the invention of rifling a gun barrel (1520) by Kotter of Nuremberg, the Spanish arquebus about the same time, the expansive cartridge by the Frenchman Honiller in 1847, and the French "mitrailleuse" cannon with its 25 barrels in a group (1866), practically all the great inventions in fire arms are attributable to English-speaking people.

Someone recently remarked that the mule is the only "engine of war" not invented by the allied nations, but even here caution should be exercised. It is altogether probable that the original mule is a Chinese invention, in spite of Missouri's claim of having first bred the modern army mule. At any rate, it is certain that a Missourian invented barbed wire, probably to keep his mules out of his wheat and corn. And now there are acres of American barbed wire in use to hold the Germans from seizing any more acres of France.

From machine guns, those lead-stinging hornets, to barbed wire, that steel porcupine, the weapons of modern war have been invented, with few exceptions, by the English-speaking peoples of the world.

## The Langwies Reinforced Concrete Viaduct

Concrete and Constructional Engineering

The Coire-Arosa Railway, a branch of the Swiss Federal System, starts at Coire (altitude 588 meters), the capital of the Grissons Canton. It follows the carriage road along the River Plessur as far as Sassal, and then ascends along the right or sunny aspect of the Schanfigg Valley as far as Langwies, where it crosses over to the left side of the valley to Arosa, at an altitude of 1,742 meters.

The lack of suitable building material and the difficulty of bringing heavy steelwork to the site, as well as the existence of good gravel and sand on the spot, led to the use of reinforced concrete for the construction of the viaduct.

The bridge crosses the valley with one main arch of 96 meters clear span between abutments. The theoretical rise between center springs and center crown of the arch is 42 meters. On either side of the main arch are a series of four smaller openings, each having a clear span of 14.7 meters.

The high and slender pillars of the bridge are sufficiently elastic to admit of the dilation of the railroad slab. There are expansion joints at the top of the supporting double pillars. Owing to its great altitude (1,320 meters above sea level), the viaduct is exposed to extensive changes of temperature, and therefore the question of expansion and contraction had to be carefully considered.

The central span comprises two separate arch rings, the thickness of which is 2.10 meters at the crown. The width of either rib at the crown is 1.00 meter, and, being battered lengthwise, it increases regularly from crown to springer. The two arch rings are tied together by means of rigid cross beams.

The peculiar arch-centering, Fig. 1, is well worth special mention. The upper part of the falsework has been constructed in the form of a fan built up with round timber obtainable on the spot in great lengths, at a low price and of good quality. This timber scaffolding is supported by three reinforced concrete towers which have been constructed in the form of framework or skeleton towers. It was not advisable to obstruct the valley too much by falsework, as the scaffolding is exposed to danger from floods when the snow melts and the two mountain brooks which join just on the bridge site carry down enormous masses of water and pebbles. Scaffolding of uprights was out of the question and the tower system only was suitable. Timber-work towers would have obstructed the passage more than reinforced concrete towers, and furthermore they would not have possessed the same amount of stability. The substructure and the foundations would in any case have required the use of reinforced concrete even if timber-work towers had been erected, as the driving of wooden piles was absolutely impossible on account of the nature of the subsoil, which was composed of coarse pebbles intermixed with loose blocks of stone.

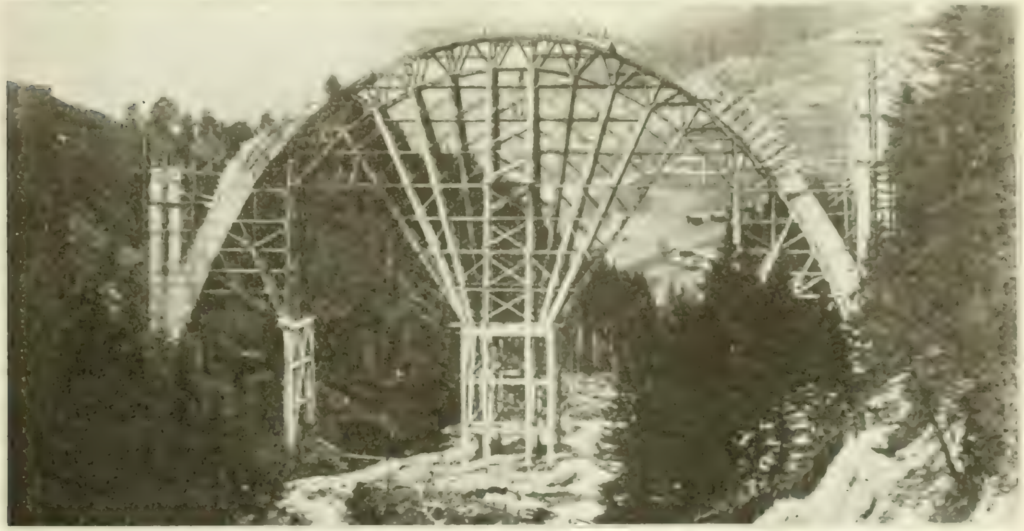


Fig. 1—Arch Centering for Reinforced Concrete Viaduct, Langwies, Switzerland

The total settlement of the main arch had to be reduced to a minimum, and this also was another reason for using reinforced concrete for the towers. When the central arch was closed the arch centering showed a total settlement of, roughly, 30 mm., inclusive of 10 mm. which occurred through the head pieces of the diagonal struts cutting into the capping-pieces of the stringers.

The concrete towers have a height of 22 meters above the water level. The huge fan-centering required over 700 cu. meters of wood. The complete viaduct contains about 250 metric tons of reinforcement metal.

# Excess Lime Treatment System for Aberdeen (Scotland) Waterworks

The Engineer

For years the authorities in Aberdeen hesitated between using the unpolluted waters of the Avon, which could be used without filtration, and the supply from the Dee. Finally the greater nearness of the latter prevailed, and the Water Commission secured the services of Dr. Houston, whose excess lime treatment was attracting considerable attention.

Dr. Houston advised the treatment of Dee water with from 1 to 2 parts per 100,000 of lime, storage for about one week, artificial carbonation, if required, and finally sand filtration.

A plan of the installment works for taking advantage of the excess lime process is shown in Fig. 1.

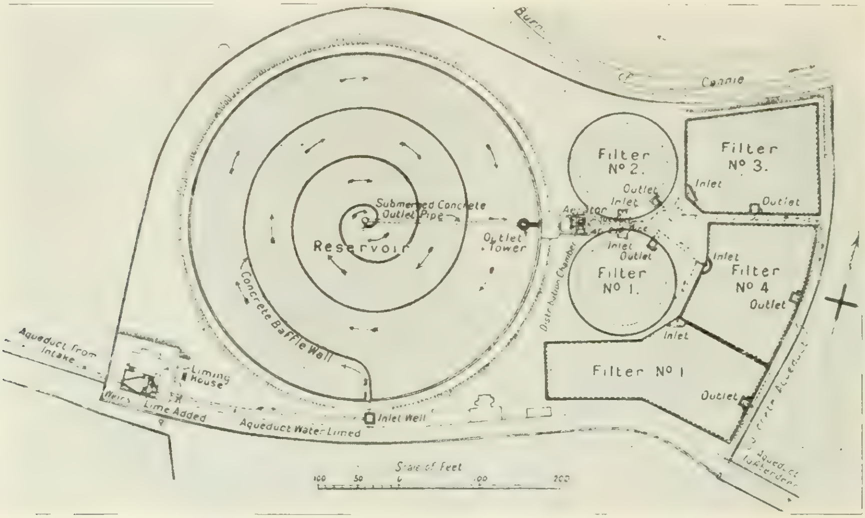


Fig. 1—Plan of Installment Works for Excess Lime Treatment.

As the corporation owned only a small area of land and had at that time no powers to buy more, the best advantage had to be taken of the space available, and this governed the shape of the filters. The works shown consist of a gauge basin where the water, on its way to the settling reservoir, passes over a rectangular weir, where it is measured. During its passage through this basin the water receives its dose of lime, which has previously been measured in a liming house close by.

The lime and water mixture is automatically measured into the water supply by means of a water motor which is worked and governed by a fixed proportion of the water passing through the gauge basin. After leaving the latter the water passes to a reservoir which is furnished with a helical baffle wall made of reinforced concrete 6 in. thick. This wall, by preventing any possibility of short-cutting of the water from the inlet to the outlet, ensures the full beneficial storage effects of the reservoir capacity. The water, after being guided by the baffle wall to the center of the reservoir, finds its way out by means of a submerged concrete pipe, through which it flows to an aerator and thence to slow sand filters, where a proportion of the added lime, since precipitated, is strained out again. The experiment of the excess lime treatment has been most satisfactory.

# A Welsh Surveyor's "Salary" Four Pence a Day!

The Narberth, Carmarthenshire, Urban District Council considered at their last meeting the resignation by Mr. W. G. Mathias of the post of surveyor. On being asked for his reasons for tendering his resignation Mr. Mathias replied that they were three in number, viz.: (1) That the council did not advance him the necessary money to pay wages; he had to run over the town to borrow money with which to pay his help. (2) The salary he received for doing all the work pertaining to the office of surveyor amounted to only 4d. (8 ct.) a day, and there was a good bit of work to be done. (3) There was more trouble in carrying out the work of dealing with 1½ miles of streets than in dealing with 101 miles of roads in the rural district.

The surveyor was asked to withdraw from the meeting while the salary question was considered in private. On his return the chairman said the council had instructed him to ask Mr. Mathias to allow the wage question to stand over until after the war.

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**Proportionate Cost of Labor and Material in Building Work.**—The following table showing the proportion of cost of labor and materials for the various items in the construction of a building is taken from the Surveyor and Municipal and County Engineer:

| | Labor, per cent. | Materials, per cent. |
|---|---|---|
| Excavating | 90 | 10 |
| Concreting | 17 | 83 |
| Drain laying | 33 | 67 |
| Bricklaying | 30 | 70 |
| Mason work | 50 | 50 |
| Carpenter work | 30 | 70 |
| Plumbing | 25 | 75 |
| Plastering | 60 | 40 |
| Smithing and foundry work | 30 | 70 |

# The Economics of Ladder Dredgers and Steam Hoppers

By HAROLD BERRIDGE.

[illegible]

Information relating to dredging operations and appliances is rarely complete, many items essential for the purposes of comparison being omitted, while statements as to costs are often misleading. Clearly the true cost of dredging cannot be arrived at by dividing the working costs for a month or two by the output, as general overhauls, interest on capital, sinking fund charges, and idle time must all receive consideration. No two works are carried out under exactly similar circumstances, and among the varying factors may be named price of fuel, hardness of dredged materials, distance of transport, regularity of employment, and the presence of tidal currents of ever-varying velocities, while in addition, even if the machines compared were of equal efficiency, it is extremely likely that the officers and crew in one case would be better than in another. Thus the information most frequently given, namely, the cost per unit output, is really of very little value as compared with that showing the cost of working the machine per unit period coupled with some indication of the amount of lost time.

The difficulties are enhanced by the numerous discrepancies that appear in printed matter concerning dredgers, and an error may easily creep in through the builder's custom of giving the speed in miles per hour, while in the case of all other vessels the unit is the knot.

The author has confined his attention to ladder dredgers, but claims that his methods of effecting comparisons, as laid down in the tables, are applicable to all types.

The cost of dredging may be divided under two main heads:

A. Standing Charges.
  (a) Establishment.
  (b) Stores.
  (c) Repairs.
  (d) Depreciation and Insurance.
B. Fuel.

**Standing Charges.**—The charges under this head, unlike those under Fuel, do not vanish even when the plant is laid up, and in no case do they diminish pro rata with the work done.

A dredging plant is rarely worked to its full capacity; in many places the work is seasonal, in which case advantage is taken of the idle season to effect major repairs, sometimes necessitating a long sea voyage to reach a graving dock. (See Table I.) In the case of contractors' plants, the work is made as continuous as possible, the special repairs being delayed, if at all possible, until the end of the job.

As regards the sub-headings:

**Establishment.**—It is found that, whether the crews are European or native, the total cost will be much the same, the lower rate of pay of natives being offset by their lower efficiency. The dredging master, mate, chief and second engineer are almost invariably Europeans. In cases where a special shore staff is provided, the dredging plant must of course bear its proportion of the cost. In work carried out under contract, where the exact cube can be arrived at, a moderate bonus can be given and will produce good results; but where departmental work is concerned, when upkeep merges into improvements, the output is so difficult to check that a bonus is open to abuse.

**Stores.**—These can be economized by purchasing the best quality obtainable, and by putting both deck and engine room on allowance.

**Repairs.**—These are best carried out at the contractor's [illegible] time is of such paramount importance, as shown by the fact that the standing charges of a 750-cu. yd. hopper dredger amount to no less than £2 per hour.

**Depreciation and Insurance.**—The word depreciation is used in its widest sense, and includes interest and sinking fund. The two items together constitute a most important disbursement, often amounting to 30 per cent on the total cost of dredging; thus any statements of working costs in which these items are ignored are comparatively valueless. At Swansea the depreciation is reckoned as equal to half the working costs, a figure which is confirmed by Mr. W. H. Wheeler, M. Inst. C. E., from experience elsewhere.

As regards capital costs, a cheap-built dredger with a life of 10 years may work just as economically as one of twice the durability, and it may pay to buy such plant and write off its low cost during the job it was bought for. The life of a dredger built substantially by a good firm may be taken at 20 years; the hull and machinery, if reasonably well kept up, being capable of wearing out two sets of boilers, which latter frequently suffer unduly through carelessness of the fireman in quenching their hot ashes in contact with the front plate.

**Insurance.**—The insurance premium averages 2 per cent per annum on the capital value of the plant, and care should be taken to provide in the policy for a rebate during unemployment.

In the generalizations which follow the author has made these assumptions:

(1) That the vessel's life is 20 years, and thus 8 per cent per annum is required for sinking fund and 5 per cent per annum interest.

(2) That insurance was at the rate of 2 per cent per annum.

(3) That the year contains 3,000 working hours.

(4) That of coal costing £1 per ton, 2 lb. is required for each I. H. P.

**Fuel.**—This is usually only a small fraction of the cost of dredging, but the power absorbed by friction is anything from 50 to 70 per cent of the total work done. In estimating the actual foot pounds of work done by a dredger, the weight of earth in air multiplied by the height from dredging level to top tumbler is usually all that is considered, whereas with the material is a large quantity of water, a great deal of which leaks away before the top tumbler is reached. As against this, however, must be set the difference due to diminished weight of the dredged material being partially water-borne. Then, again, no account is usually taken either of the resistance offered by the material to cutting, or the trailing of possible three or four buckets along the rough bottom—items incapable of anything better than being guessed at. The amount of water lifted may be taken as 25 per cent of the material delivered, a figure which may be multiplied by four under ordinary working conditions.

**Weight of Material Dredged.**—As regards the weight of the material dredged, it has become almost customary to take this at 112 lb. per cubic foot, but in estimating the work done some nearer figure should be procured, as the material may vary between, say, 96 lb. for mud, 113 lb. for sand, and 128 lb. for clay. Taking the weight of a cubic foot of sea water as 64 lb., and characterizing by the letter D the depth below the surface of the dredged bottom, by H the height of the top tumbler above water, by Q the cubic feet of dredged material brought up per minute, the power required above water is given in all cases as Q W (1.25H) on trial trips and Q W (2H) in working conditions, whereas the power used in raising the materials below the water, varying with the density of the particular material, would be in the case of mud weighing 96 lb. per cubic foot $QWD\left(\frac{96-64}{96}\right)$ or $\frac{QWD}{3}$ for mud, and adopting the same reasoning for sand weighing 112 lb. per cubic foot $\frac{3\ QWD}{7}$ and $\frac{QWD}{2}$ for clay, figures which are independent of the conditions of working. Thus, for what may be called the "estimated HP," the following formulas are obtained:

| Material. | Trial trips. | Working conditions. |
|---|---|---|
| Mud ............... | $QW\left(1.25H + \frac{D}{3}\right)$ | $QW\left(2H + \frac{D}{3}\right)$ |
| Sand ............... | $QW\left(1.25H + \frac{3D}{7}\right)$ | $QW\left(2H + \frac{3D}{7}\right)$ |
| Clay ............... | $QW\left(1.25H + \frac{D}{2}\right)$ | $QW\left(2H + \frac{D}{2}\right)$ |

The units of a pound and a foot being used, the figure obtained by each respective formula when divided by 33,000 will give a horse power unit, which can be used for purposes of comparison, and to which the author has applied the name of "estimated HP."

The results obtained by applying the formula to various dredgers show that if unity is taken as the "estimated HP.," the I. HP. required in the case of mud is 3.5, in the case of ordinary clay 5.1, in that of clay with stones and boulders 6.8, and in that of hard compace red sand 7.8.

**Coal Consumption (all purposes).**—Inasmuch as the average output of a dredger under working conditions is somewhere between 20 per cent and 30 per cent of the nominal capacity of the bucket-chain, a figure obtained at Aden while dredging nearly 2,000,000 cu. yd. and confirmed by the Italian experiments, it follows that a great deal of coal is wasted in turning round the gear and lifting water, while, in addition to this, a very large quantity is accounted for by the auxiliary machinery, such as winches, pumps, evaporators, and electric light. With hopper dredgers the coal consumed in auxiliaries is much greater even than in the case of fixed dredgers, as slipping and picking up mooring and hoisting ladders have to be carried out in addition. Then again, in hopper dredgers one of the twin engines alone is used for dredging, and this at about half power, while as regards the other engine and boiler, steam has to be kept on the latter, and the former has to be warmed up at each trip.

TABLE I.—SHOWING OCCUPATION OF PLANT.

| Name. | Port. | B Barge loading. H Hopper dredger | Hours per annum. | | | | Total working hours. | Days per annum dredging. | Dredging time, percentage of total. | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Dredging. | Depositing. | Repairs. | Other delays. | | | | |
| Mermaid ................ | Aden ............ | H | 949 | 494 | 785 | 432 | 2,660 | 268 | 28 | Av. 7 years. |
| Famagusta ............... | Aden ............ | H | 2,910 | 1,290 | 540* | ..... | 4,740 | 274 | 61 | 1⅔ years. |
| Newport ................ | Aden ............ | H | 4,360 | ..... | 840* | ..... | 5,200 | 320 | 84 | 1 1/12 years working as B. |
| Shunkai (1 and 2)........ | Osaka ............ | H | 1,915 | 275 | 1,040 | 1,193 | 4,420 | 263 | 43 | Av. 3⅔ years working as B. |
| Asanagi and Yunagi..... | Osaka ............ | B | 1,682 | ..... | 1,230 | 1,838 | 4,570 | 245 | 37 | Av. 6¼ years. |
| Octopus ................. | Bombay ......... | B | 1,245 | ..... | ..... | ..... | 2,335 | 221 | 53 | 1909-10. |
| Kuphus ................. | Bombay ......... | H | 1,002 | ..... | ..... | ..... | 1,991 | 197 | 50 | 1909-10. |
| Percy Sanderson......... | Sulina Danube..... | H | 908 | ..... | ..... | ..... | 2,609 | 151 | 28 | Av. 6 years. |
| Karnafuli I.............. | Chittagong ........ | H | 956 | ..... | ..... | ..... | 1,719 | 175 | 56 | Av. 4 years. |

*Includes repairs and other delays.

TABLE II.—SHOWING STANDING CHARGES, £ PER HOUR. LADDER HOPPER-DREDGERS.

Formula:—Standing charges = £ (0.65 + 0.00236c) when capacity of hopper — cubic yards (c).

| No. | Name of dredger | Hopper capacity, cubic yards (c). | Wages. | Stores, etc. | Repairs. | Depreciation. | Total standing charges. | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Actual. | Calculated. |
| 1. | Agnes ............ | 130 | £0.33 | £0.05 | £0.40 | £0.33 | £1.11 | £0.96 |
| 2. | Shunkai 1 and 2... | 445 | 0.17 | 0.03 | 0.31 | 0.98 | 1.49 | 1.70 |
| 3. | Cornwall .......... | 490 | 0.53 | 0.04 | 0.40 | 0.80 | 1.77 | 1.81 |
| 4. | Mermaid .......... | 740 | 0.57 | 0.19 | 0.67 | 0.86 | 2.29 | 2.40 |
| 5. | Kuphus ........... | 740 | 0.64 | 0 25 | 0.79 | 0.86 | 2.54 | 2.40 |
| 6. | Percy Sanderson... | 930 | 0.62 | 1.00* | .... | 1.07 | 2.69 | 2.85 |

*Stores, etc., and repairs.

TABLE IV.—STEAM HOPPER BARGES. STANDING CHARGES £ PER HOUR.

Formula:—Standing charges = 0.061 + 0.00168c, when capacity of hopper = cubic yards (c).

| No. | Name. | Wages. | Stores. | Repairs. | Interest and depreciation. | Actual total. | Calculated total. | Capacity of hopper = c. |
|---|---|---|---|---|---|---|---|---|
| 1. | Nos. 508, 66 (Aden).... | £0.30* | .... | £0.02 | £0.08 | £0.40 | £0.48 | 250 |
| 2. | Curlew ................ | 0.12 | 0.07 | 0.14 | 0.25 | 0.58 | 0.57 | 297 |
| 3. | Mudlark ............... | 0.12 | 0.06 | 0.17 | 0.25 | 0.60 | 0.57 | 297 |
| 4. | Snipe ................. | 0.12 | 0.07 | 0.17 | 0.25 | 0.62 | 0.57 | 297 |
| 5. | Gull .................. | 0.27 | 0.11 | 0.25 | 0.62 | 1.25 | 1.32 | 740 |
| 6. | Heron ................. | 0.24 | 0.10 | 0.28 | 0.62 | 1.14 | 1.32 | 740 |
| 7. | L.C.C. Sludge Steamers | 1 36* | .... | 0.08 | 0.80 | 2.24 | 2.24 | 1,300 |

*Wages and stores.

TABLE III.—SHOWING COST OF DREDGING BY STATIONARY DREDGERS.

| No. | Name. | Coal. Lbs. per hour. | I H P. | Capital cost. £ | Depreciation. £ per annum. | Depreciation (3,000 working hours during year). £ per hour. | Wages. £ per hour. | Stores. £ per hour. | Repairs. £ per hour. | Coal. £ per hour. | Total. £ per hour. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Asanagi and Yunagi....... | 180 | .. | 7,350 | 735 | 0.24 | 0.05 | 0.02 | 0.09 | 0.08 | 0.48 |
| 2. | Toredo ................ | 398 | . | 18,650 | 1,865 | 0.62 | 0.48 | 0.16 | 0.65 | 0.17 | 2.08 |
| 3. | Delta ................... | . | 180 } | 36,000 | 3,600 | 0.60 | .... | .... | .... | .... | 3.75 |
| | Hartley ............... | | 250 } | ...... | ..... | | | | | | |
| 4. | Octopus ............... | [illegible] | ... | 35,300 | 3,530 | 1.18 | 0.43 | 0.15 | 0.67 | 0.39 | 2.87 |

Both in the case of fixed and of hopper dredgers, some considerable time is lost on each cut when reversing the direction of traverse, a loss which is, of course, proportionately reduced as the length of cut is increased. In order to effect this economy, certain Dutch and Canadian dredgers use, instead of a head chain, a long wire rope buoyed in such a way as to keep it form resting on the bottom. With this arrangement the length of cut can be as much as 750 ft., or, say, three times that possible when a chain is used.

As regards actual coal consumtion, about 22 lb. of coal is burnt per "estimated HP.," hopper dredgers burning rather more and fixed dredgers rather less. If the "estimated HP." be multiplied by the factors, it follows that, even when working in clay, the auxiliaries use as much coal as the dredging itself.

The power required to propel hopper dredgers is of course very high, and depends so much upon the special boat and the cleanness of the hull that little useful information can be given; but the author confesses some doubt whether any real economy is generally secured by fitting triple-expansion engines having regard to the enhanced initial cost and the increased weight to be transported, to say nothing of the maintenance of additional moving parts and the wear and tear due to the higher temperatures and pressures.

**Comparison of Barge Loading and Hopper Dredges.**—No definite opinion can be given upon the vexed question of whether barge loading or hopper dredgers are the most economical, as the whole question depends upon the particular site. In an exposed place, with a short transport, clearly the hopper dredger would have the advantage; but under shelter, particularly if the material is free working, the fixed dredger with attendant hoppers would prove the better tool. The conditions favorable for one or the other method of dredging appear to be as follows:

| HOPPER DREDGER. | FIXED DREDGER AND BARGES |
|---|---|
| Maintenance work and gradual development of port not limited by time. | Special work limited by time. |
| Moderate output. | Large output. |
| Short transport, say, under 10 miles. | Long transport, say, over 10 miles. |
| Hard or variable material. | Uniform soft material. |
| Exposed position. | Sheltered position. |

## Working Costs of Municipal Motor Ash Trucks at Nottingham, England

(The Surveyor and Municipal and County Engineer.)

Mr. John Terry, cleansing superintendent of Nottingham, presented to the Corporation Wharf Committee the following statistical information:

WORK DONE BY THREE MOTORS TO FEB. [illegible], FROM OCT. 16, 1915; MARCH 11, 1916, AND DEC. 9, 1916.

| | £ | s | d |
|---|---|---|---|
| Wages | [illegible] | [illegible] | 5 |
| Operating cost | [illegible] | [illegible] | [illegible] |
| Total | [illegible] | [illegible] | [illegible] |
| Dry ashes removed | [illegible] | | |
| Average cost per ton by motor | [illegible] | | |
| Average cost by horses | [illegible] | | |

FIVE WEEKS ENDING MARCH [illegible]

Four motors.

| | £ | s | d |
|---|---|---|---|
| Wages | [illegible] | [illegible] | [illegible] |
| Operating costs | [illegible] | [illegible] | [illegible] |
| Total | [illegible] | [illegible] | [illegible] |
| Dry ashes removed | [illegible] | | |
| Cost per ton | [illegible] | | |

Working costs include depreciation, 10 per cent; insurance, £8 10s. per year; repairs, £20 per year; current, 1¼d. per unit; tires, 1.1d. per mile.

## Reinforced Concrete Base for Pavements in Sheffield

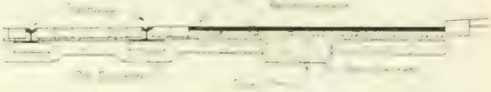
(The Surveyor and Municipal and County Engineer.)

Sheffield has had little difficulty with the concrete foundations of its street pavements. Perhaps the fact is due to the nature of the concrete, which is generally broken grit-stone or brick, very angular and absorbent. In two cases, however, several thousand yards of reinforced cement base have been laid and have been used with excellent results.

A section of road in Hereford St. had to be broken up to lay a storm-water sewer. A trench 8 ft. to 9 ft. wide and about 11 ft. deep was excavated. It was necessary to repave at the earliest opportunity, and as it was certain that subsidence would result unless special measures were taken, it was decided to use reinforced concrete with an asphaltic surface instead of replacing the old setts.

The average thickness of the concrete was 9 in. The material used was about 7½ parts broken stone and sand to 1 part cement, and the work was carried out in accordance with the instructions of the B. R. C. Co., which was undoubtedly the cheapest practicable way of repaving this street. The weight of traffic amounts on an average to about 954 tons a day, including about 30 motor lorries and trailers and an occasional traction engine.

The second piece of reinforced concrete roadway was laid under far more severe conditions in Attercliffe Common, Sheffield. Here an enormous amount of heavy traffic passes to and fro between some of the largest and most important steel works for which Sheffield is famous. Excluding tramcars, of which there are approximately 1,300 a day, more than 2,200 vehicles pass over this street daily; 500 of these are heavy motors.



Section of Roadway, Attercliffe Common, Sheffield.

During the week in which the census was taken over 400 rubber-tired lorries with an average weight of 6 tons each passed along the street, and about 120 steel-tired lorries weighing 10 tons each. On this basis the total weight of traffic passing over the street, excluding tramcars, was 6,369 tons daily, according to the Road Board formula, but actually much more. The carriageway is 12 yd. wide; therefore the average weight per yard of width works out at over 500 tons.

A part of the margin of this old granite-paved road had to be relaid and a sewer laid along the edge. The drainage work was done, and two months later the section was repaved.

In this case the reinforcement was laid on the top of the old concrete, spanning the sewer trench as shown in Fig. 1. The average thickness of the concrete was 10 in. and the proportions 5 parts broken stone and sand to 1 of cement. The new wearing surface is asphaltic. After 12 months of use there is no sign of subsidence.

The initial cost is less than either granite or wood paving, and to renew the wearing surface is a cheap and easy matter. Such paving is very clean and easily swept; there is no noise during the passage of either steel or rubber-tired lorries, and vibration is entirely absent.

# Corrosion of Steel Wharves at Kowloon and Method of Encasing Members in Concrete

Proceedings Institution Civil Engineering: Abstract of a paper read by Mr. S. H. Ellis before the Institution.

The wharves were constructed in 1907-09, and are situated on the mainland side of Hong-Kong Harbor, at the southwestern corner of the Kowloon promontory They belong to Messrs. Holt & Co. of Liverpool, the ships of whose "Blue Funnel" line of steamers, of a capacity of 6,000 to 10,000 tons, use No. 1 wharf for discharge and loading. Wharves No. 2 and 3 serve for lighters, native craft, and an occasional small coasting steamer.

In 1906, in connection with the reconstruction of a wharf, an examination was made of some steel-joist piles which had been in place about 4 years, and they were found to be corroded in a curious and rather alarming manner.

Any steel immersed in sea-water at Hong-Kong becomes quickly coated with barnacles and other shellfish, and with a dense vegetable growth, particularly from near the surface of the water to 15 ft. or so below it. It had been an accepted theory that this growth protected the metal and prevented rusting. On scraping away the growth from a pile of the wharf examined, however, it was found that a large number of pits had formed in the surface of the steel, varying in size up to 1¼ in. diameter, and ⅜ in. deep. They were full of a black carbonaceous powder, which was also found in a thin layer on the surface of the unpitted steel (though no rust or scale could be observed there), and which, on exposure to the air turned to a dark red color. This powder was found to be sulphide of iron ($F_eS$), and its change of color to be due to oxidation. Apparently some particular shellfish or other marine growth attached to the piles produces large quantities of sulphuretted hydrogen when dead and decaying. This sulphuretted hydrogen attacks the metal with an accentuated action in certain spots.

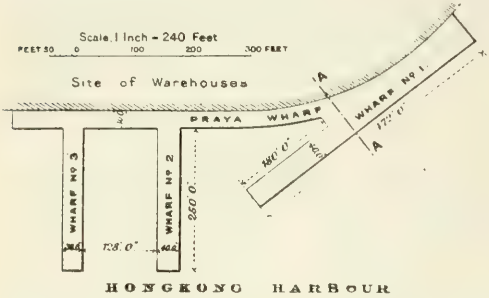


Fig. 1—General Plan of Wharves at Kowloon.

The author examined at that time some steel piles of an H-iron pattern, which had been in place only 3 or 4 years, and estimated that 10 per cent of the metal was eaten away in some sections, chiefly in the form of pitting.

The destructive effects of the marine growth appear to be confined to the part between low-water level and 15 ft. below it, the zone of worst corrosion extending from 5 ft. to 10 ft. below low-water level.

As a result of his inspection the author recommended that the piles and lower bracing of the main (No. 1) wharf should be encased in cement concrete and it was eventually decided to encase the whole of this structure, leaving the other wharves—Nos. 2, 3, and that fronting the Praya Wharf—with bare steel, which was painted with anti-corrosive composition on erection.

The method adopted in encasing the piles of No. 1 Wharf was the following: The piles—12-in. by 12-in. 8-lb. joists in single unspliced lengths up to 78 ft. —were first driven with an ordinary pile driver. Welded-steel cylinders, 20 in. in diameter inside, with metal ¼ in. thick, were then dropped over the piles and tapped down into the mud with an 8-cwt. wooden hammer. The face row of piles, being driven in close pairs, were enclosed in cylinders 3 ft. in diameter, built up of ¼-in. steel plates with riveted joints. A depth of 4 ft. to 15 ft. of the bottom of each cylinder (according to its depth) was then filled with 1:1:4 Portland-cement concrete, lowered down through the water in metal hopper-boxes, and when this had set the cylinders were pumped dry at low water and filled with concrete thrown in and rammed in place.

The wharf superstructure was coated with concrete by encasing each member in temporary wooden moulds.

A minimum cover of 2½ in. was provided to the steel throughout, the concrete being of Portland cement of standard quality, sand, and granite broken to pass a ¾ in. ring, in the proportion of 1:2:4 by measure, mixed by hand.

In July, 1913, there were obvious indications of corrosion on the surface of the concrete. Most of the diagonal members had developed longitudinal cracks —all the cracks having formed in line with the outer edges of the channels of which the various members were built up.

Thorough examination of the whole structure revealed that above high-water level corrosion appeared to have gone on almost unchecked by the presence of the concrete covering, and a thickness of about 1/16 in. of rust-scale was found on all the steel.

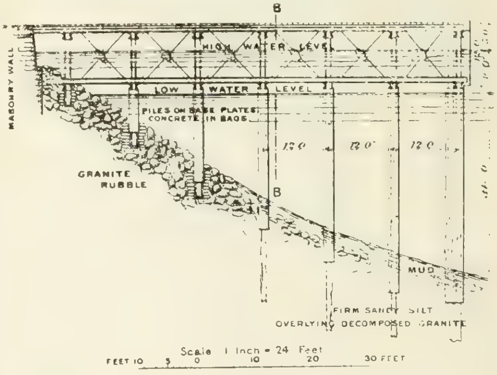


Fig. 2—Cross Section of Wharf No. 1 on AA (Fig. 1).

Although the workmanship was not everywhere good, the author was forced to the conclusion that even when perfectly encased in a 2½-in. covering of sound, homogeneous concrete, the steel was not protected against the effect of excessively damp, salt air in that climate.

The limit of serious rusting may be taken as high-water of neap-tides; below that level the corrosion diminished rapidly down to mean-tide level, and there it practically disappeared. The lower bracing members of the wharf were all found to be entirely unaffected by corrosion.

The author concludes that while steel protected by concrete has little or no tendency to corrode if it becomes thoroughly wet twice in the 24 hours, yet when it is exposed to air rendered constantly damp by the evaporation of sea-water, especially in a tropical climate, some other external coating must be sought for.

Steelwork, both exposed and embedded in concrete, in warehouses on the same property is not thus affected. Neither, in the author's experience, does the evaporation from fresh water affect steel embedded in good concrete.

# Clinker vs. Gravel as a Nidus

By JOHN E. FARMER.

The Surveyor and Municipal and County Engineer

The writer believes that the cause of the difference between two materials when used as a nidus is due to greater surface area rather than to greater absorptive powers.

To find the purification afforded by clinker as compared with gravel, a filter was constructed in two halves, one half filled with clinker and the other with gravel, and fed by revolving sprinklers.

Clinker was found to give much better results than gravel, so various experiments were tried to deduce the reason. The matter of measuring the difference in surface area presented difficulties, but finally the author made use of the principle that if a solution of known strength covers a surface, and a known volume of a solvent is allowed to act on it, the resulting solution will be of a strength proportional to the amount of the substance covering the surface.

If a known volume of clinker is soaked in a known strength of salt solution, on drawing off the excess a certain amount remains on the surface, and also an amount held by capillary attraction between the different particles. If a known volume of water acts on this, and the salt is estimated, the amount of salt added to the water must be proportional to the area of the surface covered with the salt solution plus that held by capillary attraction. But the amount absorbed by the material had to be taken into account, so the following procedure was followed: a known volume of material of known grade is allowed to soak for 48 hours in a salt solution of such strength that 1 cc. = 10 millegrammes chlorine. The salt solution is then drawn off without disturbing the material, allowed to drain 20 minutes, and the same volume of water as that of the drawn-off salt solution is added, allowed to remain 10 minutes, drawn off, refilled again and immediately drawn off, allowed to drain 20 minutes, and the amount of chlorine estimated in the solution. This estimation gives the volume of salt solution on the surface of the material, and also that held by capillary attraction. To estimate the absorbent powers of material, a volume of water equal to that obtained from the last running-off is added, allowed to remain 48 hours, when it is drawn off and the chlorine estimated. The author included under the name "surface retention" both surface and capillary retention, and considers that they give a truer index of the qualities of the material for filtration purposes if taken together.

The formula to obtain in cc. the volume of the surface retention, is—

$$x = \frac{a(c-d)}{b-c},$$

when

[illegible]

The formula for obtaining the volume absorbed is—

$$x = \frac{a(e-d) - fe}{b}$$

where

[illegible] of the salt solution absorbed

[illegible] water added

[illegible]

c = chlorine in [illegible] of water after the addition to surface retention estimation

d = [illegible] in water before [illegible] water is used

e = [illegible] per cc. [illegible] standing with the material 48 hours

f = [illegible] the surface retention estimations and that added for the water

Table I shows the results of experiments regarding the water capacity of the interstices, expressed as per cent of water capacity. The vessel used was circular in plan, holding 1,500 cc. If one of much larger capacity had been used, the results would doubtless have been much closer.

TABLE I

| Grade of material | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|
| Material, clinker* | [illegible] | [illegible] | [illegible] | [illegible] |
| Material, clinker† | [illegible] | [illegible] | [illegible] | [illegible] |
| Material, gravel | [illegible] | [illegible] | [illegible] | [illegible] |

*Graded without crushing. †Graded from crushed masses

A given capacity will contain the same total mass of spheres providing that the total diameters of a row equals the length of the side on which they lie. For example, a cubic foot vessel will contain just 24 ½-in. spheres in line on any one side, or a total of 13,824. These spheres will take up 53.36 per cent of the volume, and the same percentage of volume is taken up by 1-in. or 3-in. spheres.

# Utilization of Coal Slack as Fuel

[illegible]

Coal slack or coal dust is to be found in nearly every household. It is generally used to bank a fire, burns dull, much of it drops through the grate, and is so unsatisfactory that one often pays to have it removed. No more waste of coal slack. Buy a small quantity of Portland cement, then add 1 part by measure (not by weight) to 20 parts of coal slack, mix very thoroughly in the dry state, then add gently and by degrees a small quantity of water and mix well.

Care must be taken not to make the combination too wet—it should just hold together when squeezed in the hand.

It is now ready to be placed in a mould. An excellent one is an ordinary small flower-pot, 4 or 5 in. in diameter. Press the mixture into this firmly, and it can be at once turned out by inverting the pot. Keep in a dry, cool place for 5 or 6 days, and it is ready to burn, which it will do like an ordinary lump of coal.

Alternately the mixture can be moulded in the hands like a snowball, and in a week becomes quite firm.

As a guide to correct proportions, a bucket measure (say, 3 gal.) of coal dust will require 1 1/5 pints of cement (i. e., the 5-in. flower-pot about three parts filled) and about 2½ pints of water.

# The 236-ft. Dam of Murrumbidgee Irrigation Project

The Engineer.

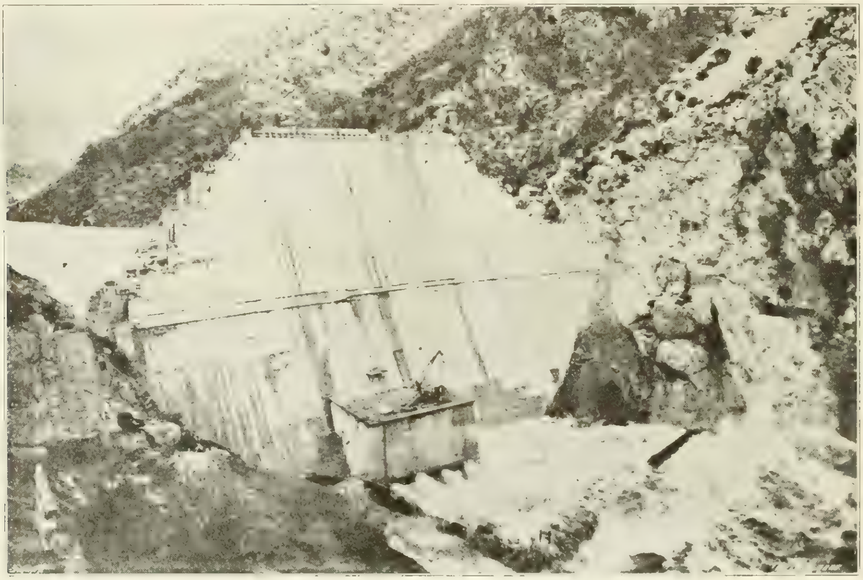
To mitigate the evils of drought in the fertile country of New South Wales the Government has for years carried on numerous and costly schemes of water conservation. One of the most important of these is the Murrumbidgee Irrigation Project which by a great dam at a place where the Murrumbidgee River traverses a deep gorge, regulates the flow of the river so that a large area, some of it 266 miles away, is effectually irrigated.

In the mountains the rainfall is heavy along the coast, reaching 60 to 70 in. in some cases, and the snow often remains all winter to melt and escape quickly in the spring. The watershed of the Murrumbidgee River, which is 5,000 square miles in extent, was chosen as the most favorable catchment. The dam at the gorge holds up the Murrumbidgee for 41 miles, and the Goodradigbee and Yass Rivers 15 and 25 miles, respectively. The gorge at the dam-site narrows to such an extent that only a comparatively small outlet had to be closed.

The construction of the dam was a clever piece of engineering. The dam itself is the highest in the British Empire, and is exceeded only by the Croton and Roosevelt dams in the United States. It is 236 ft. high, 168 ft. thick at the base, tapering to 18 ft. at the top, and about 780 ft. long at the crest.

The difficult operation of getting out the foundations was frequently interrupted, and consumed 2 years. Once 5 and 10-ton cranes were swept away, despite lashing and heavy weights, and were carried 50 miles down stream before being recovered. Even when the foundation excavations were complete, work on the dam itself could be carried on only in the height of summer when the river was low.

The river was diverted by cutting a channel in the rock at the foot of the precipitous cliffs forming one side of the gorge, and a temporary cofferdam built across the bed of the stream above the site of the dam and the water turned into the channel by this means. When the debris in the bed of the river was removed, the underlying rock was found to be hard granite, every foot of which had to be blasted out. To remove this and to handle the material for the dam, 3 Lidgerwood cableways, made by the Lidgerwood Mfg. Co., New York, each with 1,200-ft. span, were stretched across the gorge from traveling towers each 33 ft. high. The cables had a sag of 60 ft., and an elevation at the lowest point of 320 ft. above the river. The maximum working load was 15 tons, lifting 300 ft. per minute and traversing 1,200 ft. per minute, the operation being performed by two 70-HP. direct-current motors. Four boilers (two stationary tubular set in brick work, one locomotive style and one dry-back) supplied the steam to three high-speed vertical single-cylinder engines, each of 101 HP., which were coupled to direct-current generators and designed to give 135 amperes at 500 volts and 300 revolutions per minute, and to one high-speed vertical double-cylinder engine, which drove a direct-current generator designed to develop 300 amperes at 500 volts and 250 revolutions. The exhaust steam passed into another locomotive type boiler and was used to heat the feed-water. The rock drills were supplied with air by an an Ingersoll-Sergeant air-compressor, which had cross-compound air cylinders and body-type intercooler, and which was driven by a 135-HP. motor. The concrete mixers and cranes also were electrically driven.



Down Stream Face of Murrumbidgee Dam Nearing Completion.

The foundations obtained in the river bed were exceptional for the work. The foundations consisted of solid red granite, smooth and water-worn on the surface, but cut in contour by pot-holes, affording a perfect key for connecting the dam wall to the rock foundations. In taking out the gullet, a trench 10 ft. wide by 6 ft. deep, the rock was found to be without defect. The greatest depth to which the foundations were taken was to R L 948, which is 232 ft. below top-water level, or 244 ft. below crest level.

In building the cyclopean concrete a system of cruciform units with an area of 1,080 sq. ft. was adopted. These units were built to heights of 9 ft., 12 and 15 ft., and were so arranged that adjoining units broke joint both horizontally and vertically. The units were built up of heavy timber baulks, and concrete made with broken stone which had passed through a 2-in. mesh, was run in to make a bed. In this concrete boulders of an average weight of 15 tons were bedded. It was found that concrete made with this stone enabled the plums to be bedded with the best results; it was easy to handle and therefore low in cost. Over 50,000 tons of cement were used.

The dam was built with a radial curve of 1,200 ft., having its convex face upstream, the length of the chord at the crest upstream being 752 ft. The upstream face of the wall slopes 1 in 20 to R L 1132 (184 ft. level), from which line it is vertical to the crest. The slope downstream has a batter of 2 in 3 to R L 1132; 5.92 in 10 to R L 1150.75; 2.64 in 10 to R L 1171.75; 1.02 in 10 to R L 1192 (crest).

The water will be allowed to reach a top storage level at L 1180 (232 ft.). The following particulars of area and depth of water impounded when various levels are reached on the wall are interesting. The depths are taken from off-let pipes 10 ft. from the old river-bed at the dam wall:

| Available depth Ft | Cubic feet of water | Acre feet of water | Area of water surface Sq. miles |
|---|---|---|---|
| 50 | 542,912,000 | 12,464 | 1.56 |
| 100 | 3,[illegible],504,000 | [illegible]1,787 | 4.50 |
| 200 | 33,380,861,000 | 766,242 | 14.91 |

## Relative Efficiencies of Blasting Gelatine and Gelignite, as Used in Hand-Drill Stopes of the Rand Gold Mines

Journal South African Institute of [illegible]

The experiments of which the following is a summary were carried out in the course of an investigation into the possibility of increasing the ore-getting capacity of a certain set of mines.

The explosives were supplied in the ordinary course for general mining purposes. The ligdyn used was 40 per cent, and was manufactured at the dynamite factory, Somerset, West. The blasting gelatine, reef gelatine and gelignite were manufactured by the B S A Explosive Co., who give the proximate analysis and comparative ballistic strength as follows:

| Explosive. | Nitroglycerine. | Nitrocellulose. | Ammonium nitrate. | Sodium nitrate. | Wood meal. | carb. | Comparative ballistic strength. |
|---|---|---|---|---|---|---|---|
| B. G. | 92.75 | 7.25 | | | | | [illegible] |
| R. G. | 67.1 | 3.9 | 24.5 | | 4 | | [illegible]2 |
| Gelig. | 56.4 | 2.[illegible] | | 30.7 | 10.[illegible] | 1 | [illegible] |

(1) In two stopes of entirely different character blasting gelatine proved 25 per cent more efficient than gelignite as an ore breaker.

(2) The relative blasting efficiencies of blasting gelatine, reef gelatine and gelignite have been found to agree closely with the comparative ballistic strengths determined by the ballistic pendulum method in the laboratory of the manufacturers of these explosives.

(3) Forty per cent ligdyn as a primer reduces the efficiency of blasting gelatine and reef gelatine to a large extent, and probably reduces the efficiency of gelignite also.

(4) Preliminary experiments indicate that blasting gelatine gives a greater efficiency with No. 8 detonators than with No. 6's.

## Costs of the Operation of Electric Vehicles in Municipal Service

By S. L. PEARCE

[illegible]

The results herewith recorded were obtained by the Manchester (England) Corporation Electricity Department with a 1-ton "Edison" lorry from April 1, 1916, to April 1, 1917. The vehicle is equipped with a 3-HP. motor (capable of 200 per cent overload for short periods) and a standard "Edison" battery.

[illegible]

| | Week days | Sundays | Total |
|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] other than Sundays and public holidays | | | [illegible] |

Total cost for twelve months, exclusive of tires and current

| | £ | s. | d. |
|---|---|---|---|
| Wages | [illegible] | [illegible] | [illegible] |
| Material | [illegible] | [illegible] | [illegible] |
| Capital charges on the basis of the figures given in [illegible] | [illegible] | [illegible] | [illegible] |
| | [illegible] | [illegible] | 2 |

The first charge includes in addition to the drivers' wages, the cost of the labor spent on maintenance and repairs.

The cost of material appears to be rather high, but it includes an item of £6 10s. for a duplicate set of chains, which should strictly be a capital charge; chain renewals would, of course, be charged to running costs.

Other outstanding items are:

| | £ | s. | d. |
|---|---|---|---|
| Lubricants | [illegible] | 7 | 11 |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 1 | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| Distilled water | 1 | 7 | 11 |

The average miles per hour maintained during the year based on the total hours in commission, and including all loading and unloading time, in addition to the actual hours on the road were:

$$= \frac{10{,}486}{3{,}036.5} = 3.45 \text{ miles per hour.}$$

**Analysis of Costs.**

Total costs as above = £.625 0s 2d. = 63,602 pence.

$$\text{Therefore cost per mile run} = \frac{63{,}602}{10{,}486} = 6.07\text{d.}$$

To this figure has to be added the cost of tires and current. The tires have now completed the guaranteed "life" of 12,000 miles, and they cost £25 per set.

$$\text{The cost per mile therefore} = \frac{£25 \times 240}{12{,}000} = 0.5\text{d.}$$

The average current consumption during the 12 months, including motor-generator losses, was only 1.08 units per mile, which at 0.5d per unit = 0.54d per mile.

The total costs per mile run are therefore:

| | d |
|---|---|
| Wages and capital charges, etc. | [illegible] |
| Current | [illegible] |
| Tires | [illegible] |
| | 7.11 |

And the total costs for the year are

| | £. | s. | d. |
|---|---|---|---|
| Capital charges [illegible] | [illegible] | [illegible] | [illegible] |
| Wages | [illegible] | [illegible] | [illegible] |
| Material | [illegible] | [illegible] | [illegible] |
| Current [illegible] | [illegible] | [illegible] | [illegible] |
| Tires [illegible] | [illegible] | [illegible] | [illegible] |
| | 310 | 8 | 11 |

The total cost of 7.11d per mile run may now be analyzed rather more in detail.

The average rate of driver's pay may be taken as approximately 7-½d. (15 ct.) per hour. (It is now considerably higher.)

Then since the average speed over the whole year was 3.45 miles per hour,

The cost of driving $= \dfrac{7.5}{3.45} = 2.17$d. per mile,

The capital charges = 124 9s 0d = 29,868d.

And therefore the proportion per mile $= \dfrac{29{,}868}{10{,}486} = 2.85$d.

The sum of these two items, together with the cost of tires and current = 6.06d.; therefore the difference between this amount and 7.11d. obviously represents the cost of maintenance.

The complete analysis then becomes:

| Item. | Cost per mile, d. |
|---|---|
| Capital charges, insurance, and drivers' licenses | 2.85 |
| Drivers' wages | 2.17 |
| Maintenance of vehicle and battery, including lubricants (material 0.57, labor 0.48) | 1.05 |
| Current | 0.54 |
| Tires | 0.50 |
|  | 7.11 |

These figures are based at 4½ per cent and 0.5d. (1 ct.) per unit for current; but in order to provide a better comparison with results obtained elsewhere and with present day conditions, a set of alternative costs has been prepared, based on 5 per cent interest and 1d. per

|  | d. |
|---|---|
| Capital charges, etc | 2.93 |
| Drivers' wages | 2.17 |
| Maintenance (material 0.57d, labor 0.48d) | 1.05 |
| Current | 1.08 |
| Tires | 0.50 |
|  | 7.73 |

This figure of 7.73d. (15.36 ct.) per mile compares very favorably with the cost of petrol vehicles. It is, moreover, based on annual capital charges amounting to £127 16s. 7d., or approximately 18.9 per cent of the original cost of the vehicle. This figure includes £10 for insurance and 10s. for drivers' licenses. The total amount of the interest and repayment charges is therefore £117 6s. 7d., and is equal to 17.4 per cent of the cost of the vehicle.

At 4½ per cent interest the corresponding amounts are:

|  |  | s. | d. |
|---|---|---|---|
| Total charges | 113 | 19 | 0 |
| Percentage of purchase price | 16.86 |  |  |

### Comparison of Electric and Horse Costs.

The charge for a light one-horse lorry and driver is taken at 1s. 6d. (36 ct.) per hour. An average speed of two miles per hour for horse lorries is assured.

On a mileage basis alone, therefore, the electric has been the equivalent of $\dfrac{3.45}{2} = 1.73$ horse lorries; but in addition there is the further saving resulting from the organization possible with a centrally-controlled electric vehicle. This is represented by the "Organization Factor," the average value of which for the year has been 1.58—i. e., 1.58 departments have been represented on every journey the vehicle has undertaken.

The electric should therefore be the equivalent of 1.75 + 1.58 = 2.73 horse lorries; but as the several departments concerned may not have been represented on the whole of the miles run per journey, and admitting the possibility of a slight amount of organization with the horse vehicles, this ration has, in order to be on the safe side, been reduced to 2.5.

The cost of the electric per hour = 3.45 + 7.11 = 24.5d. (49 ct.) and on the above basis the relative costs per week are therefore:

|  | £. | s | d. |
|---|---|---|---|
| Horse, 58.6 x 2.5 x 18d | 11 | 19 | 10 |
| Electric 58.6 x 24.5d | 5 | 19 | 7 |
| Saving due to electric | 5 | 0 | 3 |

The average hours per week the vehicle was in commission, again neglecting Sunday.... $= \dfrac{2{,}988}{51} = 58.6$.

For a working year of 51 weeks the saving due to the electric = 51 × 5 = £255.

The first cost of the electric vehicle was £675 15s. The cost of the equivalent horse lorries has been shown to be equal to £11 per week, which for a working year of 51 weeks gives a total of £561, and this amount should equal the reduction on the carting account as compared with the previous year—other conditions, of course, being equal.

The actual figures for the years ending March 31, 1916, and 1917, respectively, were:

| Year ending— | £. | s. | d. |
|---|---|---|---|
| March 31, 1916 | 1,715 | 17 | 10 |
| March 31, 1917 | 1,185 | 1 | 11 |
| Giving a reduction of | 530 | 15 | 11 |

or roughly, £531, which is in very close agreement with the above estimate.

When in commission the "standing" cost of the electric has been less than that of the horse lorries. The actual costs being—

|  | Per hour. |
|---|---|
| Horse lorry and driver | 18d |
| Electric lorry and driver (2.85 x 2.17) x 3.45 | 17.32d |

In conclusion, it is obvious from the total hours worked and miles run that the vehicle has been actively employed, with the result that our carting methods have been revolutionized.

## Reinforced Concrete Bridge with Pre-Cast Members

The Surveyor and Municipal and County Engineer.

The steel bridge at Clapham Junction, carrying the main highway from London to Wandsworth, Putney and beyond, over the main line of the London & Southwestern Ry., has been replaced by a ferro-concrete structure of the Mouchel-Hennebique type to provide more adequately for the heavy tramway traffic of the London Company Council. Serious deterioration took place in the old bridge owing to the corrosive action of the fumes emitted from locomotives, but these gases have no harmful effect on ferro-concrete, so the new bridge is safe from further trouble of the kind.

The plan of the new bridge is unusual in that all its members were so designed that they could be moulded before being placed in position. This method makes it possible to replace an old bridge in the most durable ferro-concrete without material disturbance of traffic, a most important point which has hitherto worked against the use of this material for replacements of busy urban thoroughfares, where the dislocation of heavy tramway and wagon traffic causes much annoyance and financial loss. An additional advantage is the fact that by the new method bridges can be constructed in places where the available headroom is insufficient for the erection of the shuttering required for moulding concrete in position. These departures from usual practice have proved most satisfactory.

Many Mouchel-Hennebique bridges have been successfully built without interruption to traffic by moulding the ferro-concrete work in two longitudinal halves, thus always leaving one-half free for traffic. In the case of the St. John's hill bridge a further ingenious advance has been made by the employment of purpose-moulded ferro-concrete beams and slabs, prepared and seasoned in advance and designed so that all the members could be slung and seated in their final positions with a minimum expenditure of time. Afterward the beams and decking slabs were covered with a thin monolithic slab of ferro-concrete, binding together the whole construction, on which were laid the two tramway tracks and conduit rails, road paving curbs and footpaths. Conduits in ferro-concrete were formed for the electric conductors furnishing current to the motors of tramcars, and for gas pipes, electric light cables, and cables of the Post Office Department.

When all the beams and slabs had been molded and had been hardened sufficiently for handling with perfect safety, the old steel span was removed and the new span assembled in place and finished in readiness for the relaying of the tramway tracks and road paving.

# Method of Extending Pier-Foundations of the Wanganui Bridge.

By ROBERT W. HOLMES, M. Inst. C. E.

Minutes of the Institution of Civil Engineers

The bed of the Wanganui River, Wanganui, New Zealand, consists of alluvial matter containing sand, mud, gravel and timber from trees washed down from the forests above. With the destruction of the forests which retarded the discharge of rainfall, and the narrowing of the river channel to make room for a railway station, the velocity of the current was so increased that serious erosion of the left bank occurred, as the alluvium offered little resistance to scour. A heavy flood lowered the bed of the river to within about 5 ft. of the bottom of the cylinder piers, giving a depth of about 42 ft. at high tide. A succession of minor floods caused silting until the depth was about 32 ft. at each pier when the cylinders were lowered. High floods now rise about 7 ft., or within 4 ft. of the under side of the girders, where the depth of water will be about 49 ft. after the scouring of the recent silting has taken place.

It is remarkable that no settlement of the cylinders occurred, since the river bed is soft, and whole trees, 40 to 70 ft. in length over all, and up to 4 ft. in diameter of bole, heaped up on the sharp bend just above the bridge. But it was soon apparent that the foundations of the piers were being seriously weakened, so heavy rock was deposited around them. But the floods still increased and the scour began to undermine the rock.

Since the river could not be widened, owing to the encroachment of the town, it appeared that the only way to minimize flooding and to avoid too great increase in the velocity of the river current was to deepen the channel. This, of course, precluded the further depositing of rocks.

The pier cylinders, which were found to be excellently preserved, were first sunk lower. A staging was built to support the weight of the stage and the traffic, as well as to act as a guide to the cylinders when they were being sunk. Because of its great toughness, eucalyptus paniculata was used for the main piles, white pine being used for the secondary piles. The iron bark piles in 50-ft. lengths were driven as far as possible by means of a dolly. They were [illegible] by joining on extension pieces, as shown in Fig. 1. This method alone would stand the driving. The dowel prevents any tendency to lateral movement during driving, and was found to be absolutely necessary.

The piles had to be driven deeply, so that they should not be disturbed during the cylinder sinking, which would probably have caused damage to the spans which were resting on the staying. For the braces, etc., below water green timber was used, so as to avoid inconvenience by floating when being fixed in position. Constant vigilance had to be exercised lest the driftwood brought down by the flood become dangerous.

As the bridge could not be closed to traffic, and as there was not sufficient room between the under side of the bridge and high-water mark to admit an air-lock and allow sufficient margin for sinking, it was decided to remove the short length of cylinder at the upper end of each and use a top dome to which the air-lock was attached. The top is a hemispherical dome, with a trunk on one side to support the air-lock and form a passageway between cylinder and air-lock. On the opposite side of the dome two cantilever girders were fixed, and connected with the trunk, to carry counterweights. On the lower side of the trunk the chute usually attached to the air-lock was fixed, and through this the excavated materials were ejected. This was little used, however, as the men preferred to pass both the outgoing and incoming materials through the chute when attached to the air-lock in the usual position.

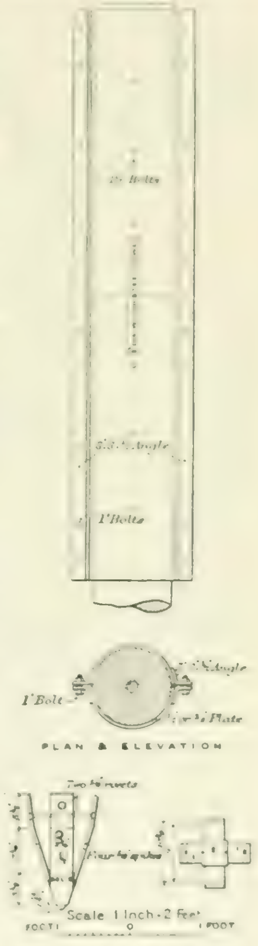


Fig. 1—Pile Scarf and Shoe

To facilitate the sinking of the shafts a small hammer drilling machine, worked by compressed air, was used with good effect, small holes being drilled and light charges of explosive used to avoid damaging the surrounding concrete and cast iron cylinder. The rate of progress exceeded expectation. On reaching the bottom it was found that the last 6 ft. had not been filled with concrete, as it had apparently been found impossible to remove the mud and fine silt to the very bottom. The concrete above water level proved to be hard and of good quality, but below water level it was inferior and softer, showing that whatever system had been adopted for placing the concrete in position under water had not been perfect. As the cylinders were not sunk by pneumatic process, no visible attempt had been made to render them water-tight or air-tight. This caused great loss of air, so that in several places a diver had to caulk the leaks outside.

As soon as each cylinder had been got into working order for sinking, the silt in the lower length of cylinder below the concrete was removed. The air pressure being then released, the cylinder sank without difficulty, the concrete remaining therein being of sufficient weight. This procedure was repeated until the additional depth of 30 ft. had been reached. At the bottom of each cylinder 2 cu. yd. of rough broken stone were first placed, then a layer of canvas, then about 6 ft. in height of concrete under air pressure which was maintained until the concrete had set sufficiently to resist the influx of water (about 24 hours). The air-lock was then removed and the shaft filled up to the top at atmospheric pressure.

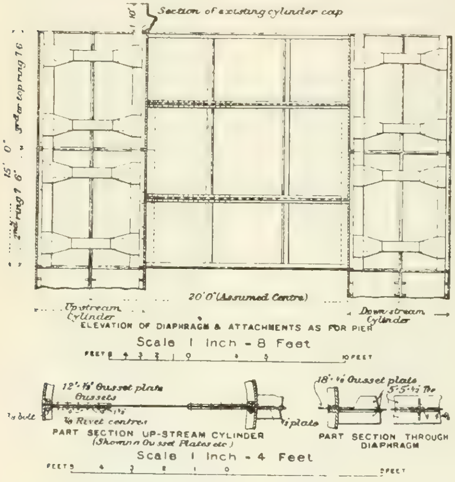


Fig. 2—Diaphragm Between Cylinders.

The two cylinders in each pier were connected above low-water mark by a substantial diaphragm which was connected diametrically through each cylinder with the opposite, so as to avoid all risk of rupturing the cylinder should the diaphragm exert excessive tension from any cause, as usually diaphragms or connecting braces are attached only to the adjacent faces of the cylinders. The diaphragm (Fig. 2) consisted of ½-in. mild steel plates, stiffened with angles and riveted to a ½-in. gusset extending to inside the cylinder, through the joint of the cast iron cylinder plates. This diaphragm served to brace the cylinders together and to prevent driftwood from catching between cylinders during floods.

A very effectual jointing material for the cylinder plates consisted of two parts of lead wire of about No. 12 gauge. Hemp, with red and white lead, was, however, principally used. The interior of the air-lock and cylinder was illuminated by electric light produced by a small direct-current dynamo driven by a 3¾-HP. Gardner kerosene engine. An Ingersoll-Rand air compressor was used, Type XI, 7 in. x 9 in., two cylinders, vertical, driven on a portable steam engine. A maximum pressure of 30 lb. per square inch proved sufficient, which was as much as the cylinders were deemed capable of standing with a fair margin of safety.

When the cylinders were completed the lowering of the trusses showed a subsidence in one only, and that for but ⅜ in. The diaphragm between each pair of cylinders was then fixed in position. During the testing period the bridge carried much fast and heavy traffic, including traction engines and great herds of cattle, which produced severe vibration.

The river bed proved very unsatisfactory as a foundation. Layers of tenacious mud, with alternate thin layers of fine gravel, were passed through, but on reaching a depth of 74 ft. below high-water mark a fairly firm stratum was reached which was judged adequate. Up to the present no signs of settlement have occurred. The appearance of caisson sickness among the men in the cylinders induced the suspension of sinking perhaps a little sooner than prudence would have justified.

The various strata forming the river bed caused the sinking to be very erratic. Sometimes the cylinder would descend only a few inches when the pressure was relieved; generally the movement reached a few feet.

The depths of the cylinders were originally 56 ft. below the bedplates of the girders. The final depths were:

Pier No. 5, 85 ft. 2 in. upstream and 79 ft. downstream.

Pier No. 6, 86 ft. 7 in. upstream and 84 ft. 1 in. downstream.

Pier No. 6 is situated on the concave side of the river, where the maximum current and scour occurs.

The work occupied eight months. The estimated cost was £6,000, the actual cost £5,249. The latter was much increased through the necessity of keeping the bridge always open for traffic.

## Cost of Operating Municipal Edison Electric Motor Tipping Trucks, Newcastle, England

The Surveyor and Municipal and County Engineer.

Mr. F. W. Sykes, cleansing superintendent, Newcastle, has published the following costs with regard to the operation of a two-ton Edison electric tipping wagon in that city:

COST OF 41 WEEKS' WORKING

July 6, 1917.

| | |
|---|---|
| Number of miles run | 3,172 |
| Number of tons carried | 2,475 |

Average lead, 1½ miles each way.

| | Actual running costs. | | | Actual running costs per ton. | | Actual running costs per mile. | |
|---|---|---|---|---|---|---|---|
| | £. | s. | d. | s. | d. | s. | d. |
| Capital charges on £1,000 for 10 years (interest calculated at 5 per cent and sinking fund on 4 per cent basis) | 105 | 1 | 10 | 0 | 10.19 | 0 | 7.95 |
| Electric energy at 3.55 units per mile, 11,250 units at 1½ per unit | 70 | 6 | 3 | 0 | 6.81 | 0 | 5.32 |
| Oil and grease | 1 | 6 | 0 | 0 | 0.12 | 0 | 0.09 |
| Maintenance of chassis, body and batteries | 11 | 3 | 2 | 0 | 1.08 | 0 | 0.84 |
| Maintenance of tires (assuming life of tires 10,000 miles) $\frac{3,172}{10,000}$ x £40 | 12 | 13 | 9 | 0 | 1.23 | 0 | 0 96 |
| Insurance at £12 15s per annum | 10 | 1 | 0 | 0 | 0 97 | 0 | 0.76 |
| Driver at £2 4s 8d per week | 91 | 15 | 8 | 0 | 8.90 | 0 | 6.94 |
| Total running cost | 302 | 7 | 8 | 2 | 5.30 | 1 | 10.86 |
| Four lifters at £1 15s per week | 287 | 0 | 0 | 2 | 3.83 | 1 | 9.71 |
| Total cost of removal | 589 | 7 | 8 | 4 | 9 13 | 3 | 8.57 |

# Methods of Sampling of Sewage and Other Liquids

By C. BERTRAM KERSHAW.

[illegible]

That sewage purification works may not be constructed and then found inadequate to cope with the sewage which they are required to treat, the sampling of sewage must be painstakingly done.

It is of the highest importance that the samples shall be representative of the bulk from which they are drawn. Since all waste liquids vary in character and volume, samples drawn according to the rate of flow of liquid over at least 4 days should be taken. Taking four days as a good average period, the author makes the tests from Monday to Friday morning inclusive, in a season of dry weather. A resume of his method follows:

Use an automatic height recorder whenever obtainable, and run it at the weir for 7 to 10 days before sampling, so as to get a line on the sewage flow. Use 30 to 36 wide-mouthed, glass-stoppered bottles of 600 to 700 cc. each. If bacterial analyses are needed, take a few small, glass-stoppered, sterilized bottles of 50 cc. each and fill one or two from the large mixing bottle when the 24 hours' average sample is made up. All stoppers should be carefully ground in with fine emery, and the foot of each stopper rounded to avoid including air bubbles. The glass mixing bottle holds 1½ gal., and is used for mixing the contents of the 24 hourly samples. Two thermometers, grease chalks, two or three drying cloths and some adhesive labels complete the outfit.

Where practicable a wooden dam with brass or gunmetal rectangular weir-plates screwed to its face is used to gauge the flow, the depth over the sill being automatically and continuously recorded. A mixture of clay and linseed oil makes watertight joints between the margins of the wooden dam and the channel walls. The width of the weir should not exceed one-third that of the channel. The transverse sectional area of the falling liquid should not exceed one-fifth of the transverse sectional area of the liquid in the channel above the weir. The weir and dam-board should be upright, with a free overfall and air space underneath the falling sheet of water, and the recorder far enough back to avoid the curvature of surface. Where an automatic height recorder cannot be obtained, depths over the weir can be taken with a thin steel rule, one edge of which is ground thin. If this is rubbed lightly against a block of wet clay and allowed to dry before each reading the exact depth is easily seen.

Assuming that the recorder is started at 9 a. m., at 9:30 take the first sample of sewage, the second at 10:30, and so on until 8:30 the following morning, when the set of hourly samples will be complete. Date each bottle with grease chalk upon the glass or use adhesive labels. As each bottle is filled, let the stopper sink gently into place to avoid breakage should force be needed to remove it. When ranged in a row a wonderfully good idea can usually be obtained of the variations in character of the sewage through the 24 hours.

If fragments of faeces are included in a sample, they should be broken up before the proportionate amounts are drawn off.

Replace the recorder with a fresh one, and work out and enter the hourly rates of flow on the finished chart. Record date, rainfall, if any, and other items of interest, such as times of strongest and weakest sewage, flushes of trade wastes, etc.

Now take from each bottle in turn an amount proportionate to the rate of flow for each hour, and transfer it to the large mixing bottle. Assuming the flow for the first three hours to have been severally 5,000, 6,500 and 8,500 gal. per hour, then if 55 cc., 65 cc., and 85 cc. are taken from the first, second and third bottles, respectively, these amounts will be proportionate to the rates of flow for these hours, and the same procedure must be followed with the 21 remaining hourly samples. Meanwhile, of course, begin to take the second set of hourly samples.

When the proportionate contents of the 24th sample bottle have been transferred to the mixing bottle, the latter may be dispatched to the laboratory carefully packed in a wicker hamper.

# Pile-Driving and the Supporting Power of Piles

By HENRY ADAMS,

M. Inst. C. E. (Past President).

[illegible] read before the Concrete Institute

**Pitching and Driving.**—In pitching a pile care must be taken that it is started in the right place, as it cannot be shifted, but if the point is not truly in line with the axis of the pile, or gets pushed to one side by meeting an obstruction before it has entered very far the lower end of the pile will be drawn over to the side to which the point leans. When out of position, piles may be drawn, back into place by chains, twisted like a surgeon's tourniquet. In building jetties the outside row of piles is often doubled, the outer pile being a raking one, at 15 to 30° from the vertical, for increasing the stability; this acts like a buttress. At the corners of jetties the outer piles are usually raking both ways, say about 15° from the vertical. When necessity arises piles may be drawn from the bed of a tidal river by lashing empty barges to them and letting them lift by the tide. Against a river wall or round the foundations of a bridge piles should be sawn off by a diver as low as he can get at them in preference to drawing them, to avoid any risk of scour and undermining of the foundation. On land a pile may be drawn by a lever or by powerful jacks.

**Weight of Ram.**—One of the most interesting questions in connection with pile driving is the proportion between weight of hammer and the amount of the fall to produce a given result. The hammer usually weighs from 5 to 30 cwt., and is allowed to fall, say, from 6 to 20 ft. Upon superficial consideration it would seem that a hammer of 5 cwt. falling 20 ft. would produce the same result as a hammer of 20 cwt. falling 5 ft., as they would both have 10,000 ft. lb. energy, but the proportion of the total energy (Wh) which is usefully expended in sinking the pile depends, among other things, upon the ratio of the weight of the ram to the weight of the pile.

A light hammer with a long fall will not have the same effect as a heavy hammer with a short fall. In practice it is found that with too great a fall the effect of the blow is to bruise and "broom" the head of the pile, or to shiver the timber instead of to force it downwards. A heavy hammer, producing the same effect in distance driven as a light one with greater fall, does less injury to the piles. It is as if the top of the pile were driven down while the bottom remained stationary, owing to the inertia of the mass of the pile.

For the first few blows the pile goes down a considerable distance, which gradually becomes less at each blow until the resistance is so great that it will not go any further, or, as it is technically called, "refuses." Generally the driving is stopped when the "set," or distance driven by the last blow, does not exceed ¼ in., or the sum of the last three blows 1 in., but of course for this to be any measure of the supporting power the weight of the hammer and the height of fall must be in some recognized proportion to the dimensions and weight of the piles.

Rankin says, "The test of a pile having been sufficiently driven is that it shall not be driven more than 1/5 in. by 30 blows of a hammer weighing 800 lb. and falling 5 ft. at each blow," and there is probably no one who would dispute the fact that if it stood this test it had been sufficiently driven; many would consider that it had been over-driven. The tendency of late years has been to increase both the weight of the ram and its fall, especially where heavy duty in supporting power is required.

**The Supporting Power of Piles.**—The sustaining power of a pile depends chiefly upon three circumstances:

(1) The resistance at the point or shoe to further penetration.

(2) The friction of the earth on the sides of the pile, and

(3) The strength, as a column, of the pile above the ground or above the firm subsoil.

The first two factors are usually combined into one formula founded chiefly upon experiments. The best known formula is that of Major Sanders, U. S. Engineers, quoted by Rankine and Molesworth:

$$R = \frac{W\ h}{8\ s}$$

This is the same as calling the safe load one-eighth of the mean resistance to the energy of the blow, assuming it to be expended entirely in penetration without compressing the pile.

In Newman's "Earthwork Slips and Subsidences" the frictional resistance of timber piles is stated to be less through wet soils than dry, in the following proportions:

In sandy gravel, 5 to 10 per cent less,

In sand about 12 per cent less,

In sandy clay or gravelly clay, about 40 per cent less.

In experiments made previous to the sinking of concrete piles for the works of the Vienna-Danube Sand Dredging Co. in 1909 it was found that the frictional resistance was about 14.19 lb. per square inch of surface = 2054.36 lb. per square foot, or just over 18 cwt.

French engineers (vide Berg's "Safe Building") allow a pile to carry 50,000 lb. provided it does not sink perceptibly under a ram falling 4 ft. and weighing 1,350 lb. or does not sink ½ in. under 30 blows.

The following rule has been given for steam driving: When a pile is driven (a) feet vertically into the ground by (n) blows of a steam hammer fastened to the head of the pile, (p) being the mean pressure of the steam in pounds per square inch, (d) the diameter of the piston in inches, (l) the length of the stroke in feet, (W) the weight in pounds of the moving part of the hammer (Wp) the weight of the pile and the fixed part of the steam hammer attached to it in pounds, the mean resistance of the ground in pounds will be:

$$Wp + W + \frac{n\quad W}{W + Wp}\quad W + \frac{1}{4} d^2p \quad \frac{l}{a}$$

There seems to be no general rule as to the factor of safety it is desirable to adopt; the practice appears to vary from 2 to 10, the former for dead loads and the latter for live or vibrating loads.

Dobson in "Foundations and Concrete Works" says that in the ordinary case if a pile will safely resist an impact of a ton it will bear without yielding a pressure of 1½ tons and he gives Wv = impact, therefore safe load = 1.5 Wv.

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# The Lake Coleridge Hydro-Electric Developments in New Zealand

The Engineer.

The Lake Coleridge installation is the first of the hydro-electric power schemes to be put in hand by the New Zealand Government under the Water Power Act of 1903. The development will supply Christchurch and the Canterbury Province. Lake Coleridge is situated in the southern Alps and lies about 70 miles to the west of Christchurch. Its surface is 1,667 ft. above sea level. It is 10 miles long, has a maximum width of 2½ miles and an area of 14 square miles. In spite of its altitude the lake does not freeze.

The lake is fed by four streams, i. e., the river Ryton, Seamander Creek, Simois Creek, and the Coleridge Creek, and the total average outflow by the lake stream is about 160 cu. ft. per second. Owing to the large storage area of the lake the flow of the stream is very steady. The power available from the present outflow of the lake is some 5,000 Kw. for continuous working. By diverting various rivers into the lake, this power may be increased to 50,000 KW. for continuous working.

The water will be conveyed from the lake to the river by a tunnel 100 chains long. This tunnel will be semi-eliptic, with a curved invert, and will be 8 ft. high and 8 ft. wide with an area of 50 sq. ft. The crown of the inlet at the inlet will be 12 ft. below lake level, the tunnel being worked under this pressure. The tunnel is provided at the outlet end with a surge chamber 30 ft. square. The surge chamber is designed in conjunction with the governors, fly wheels and reactances of the generating sets, so as to minimize as far as possible the disturbances arising from changes in the load, and to enable the output to respond automatically to the requirements of the service.

Provision is made in the power-house for an ultimate equipment of six main generating units of 1,500-KW. capacity each, and two turbine-driven and one motor-driven exciter units, each of 150 KW. These will be supplied from the surge chamber by three penstocks 52 in. internal diameter and ½ mile long, and ranging from ¼ in. to ⅝ in. in thickness. In order to prevent corrosion, the penstocks will be coated inside and outside with a high quality of bitumen compound 1/16 in. thick.

The transmission lines from the power station to the main substation at Christchurch, 70 miles, will consist of two independent pole lines, each carrying three conductors consisting either of 7/12 S. W. G. copper or 7/.135 aluminum cables carried on four shell pin insulators and spaced triangularly 6 ft. apart. A branch of the 66,000-volt transmission line will be run to Timaru—a flourishing seaport, 100 miles south of Christchurch—and ultimately in a northern direction also, with substations at intervals, transforming down to 11,000 volts at which pressure the energy will be distributed throughout the province.

# The Medlow Dam, a 65 Ft. Concrete Structure with 9 Ft. Base Width

The Medlow Dam is situated in a sandstone gorge on Adams Creek in the Blue Mountains of New South Wales. This dam is but a sheet of concrete, and because of its slender profile is one of the most remarkable in the world. The wall, which has a vertical upstream face, is built on a curve of 60 ft. radius, and is 65 ft. high from foundation to the top of the parapet wall. (Fig. 1). It has a base width of only 8.96 ft., and it tapers on the downstream face to 3 ft. 6 in. at the height of 29 ft., and from there to top-water level is of the same thickness, and finally finishes for the remaining 3 ft. of height with a parapet wall 1 ft. thick.

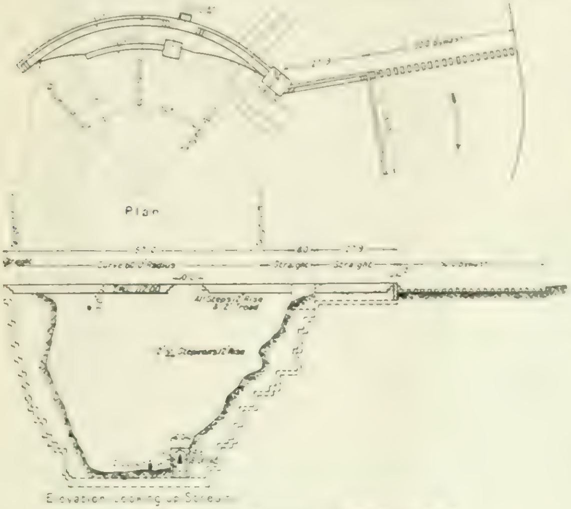


Fig. 1.—Plan and Elevation of Medlow Dam.

In determining the profile the wall was treated as a section of a rigid cylinder, subject to external water pressure, disregarding any assistance due to the weight of the wall. The formula used was:

$$T = \frac{R\,P}{S}$$

where T denotes the thickness of wall at any level in feet,

R denotes radius in feet,

P denotes water pressure in tons,

S denotes stress in tons per square foot.

The limiting pressure adopted for the concrete was 12 tons per square foot, while the highest water surface was taken as within 1 ft. of the top of the parapet wall, or 2 ft. above the overflow level of the spillway. Hence—

$$P = \frac{62.5 \times 62}{2240} = 1.73 \text{ tons}$$

$$T = \frac{60 \times 1.73}{12} = 8.65 \text{ ft.}$$

Before the building in 1907 of the Crowley Creek Dam, the old Bear River Dam, California, was regarded as an example of very bold proportioning and is referred to in text-books as having probably the thinnest profile ever used in such a structure. The Medlow profile, however, is thinner, but as the wall is built on a much smaller radius, 60 ft. as against 335 ft., the maximum pressure on the concrete is only 12 tons per square foot, as against 53 tons per square foot on the granite voussoirs in the old Bear Valley Dam.

# French Developments of Sahara Desert

It seems hardly to be realized outside of the Chancelleries of Europe that, with the establishment of the Moroccan protectorate, France entered into absolute control of 45 per cent of the area—a territory half again as large as the United States—and 25 per cent of the population of Africa, most of both, in contrast to the scattered colonies of the other powers, being compactly consolidated in the Northwest. "Nine-tenths Sahara Desert and worthless," is the natural comment of the outsider. "Desert but not worthless," replies the Frenchman confidently, for his experts have been busy for the last two decades proving that the Sahara, like most of the other great deserts, is barren only through lack of water. And water—often artesian—has been brought to the surface at almost every place where it has been sought in a scientific manner, with the result that productive oases are being created in the Sahara much after the way in which certain sections of the arid region west of the Rockies were reclaimed in the United States.

Not only do the French aim to link up the reclaimed areas as they are brought under water, but pushing construction ahead of reclamation also to bring their populous colonies of the Suydan and the Niger basin into connection with the Mediterranean by means of two or more great trans-Saharan lines. Careful studies extending over many years have shown that all of these projects are not only feasible from an engineering standpoint, but also likely to be profitable from a financial one.

France's most ambitious railway project is one by which a line starting from the Mediterranean will be thrown across the Sahara to the healthful and well-populated states of Wadai and Kanem in the Lake Chad region, on through the Congo, using any available Belgian construction as a part of the main trunk, to connect with the Rhodesian Railways in the vicinity of the Katanga border. This route, it is pointed out, because it is entirely by land, and because Algiers is 36 hours nearer Paris and London than Alexandria, would make the journey to South Africa several days shorter than by the Cape-to-Cairo, which will, for many years, use lake and river steamers for a quarter of its length.

**Electric Locomotives for Swiss Railway.**—The Swiss Federal Government has authorized the expenditure by the Federal Railways of $8,242,000 for the purchase of 20 electric locomotives. The cost of these locomotives is three times as much as previous to the outbreak of the war.

# Compressed Air Sewage Lifting System of Cairo, Egypt

Minutes of Proceedings of the Institution of Civil Engineers.

The drainage of the low-lying portion of the city of Cairo, Egypt, is on the sectional system, worked by compressed air, for which 63 Shone ejectors have been sunk in the positions shown in Fig. 1. Each ejector-station consists of cast-iron, water-tight tubbing of sufficient diameter to contain two, and in two cases, three ejectors of the size required for lifting the sewage of each area. Each ejector being capable of dealing with the maximum dry-weather flow from the area served, the second acts as a stand-by. Where the area is drained on the combined systems, the capacity of each ejector is half the maximum wet-weather flow.

The tubbings for ejectors were sunk, where the conditions permitted, in open cuttings, but where the subsoil water level was high and the flow abundant, air-pressure sometimes attaining about 10 lb. per square inch was resorted to. The tubbing was made in segments, which were erected in situ, and the joints were rendered water-tight with lead. The floors are of cast-iron segments bolted together and stiffened with girders concreted over.

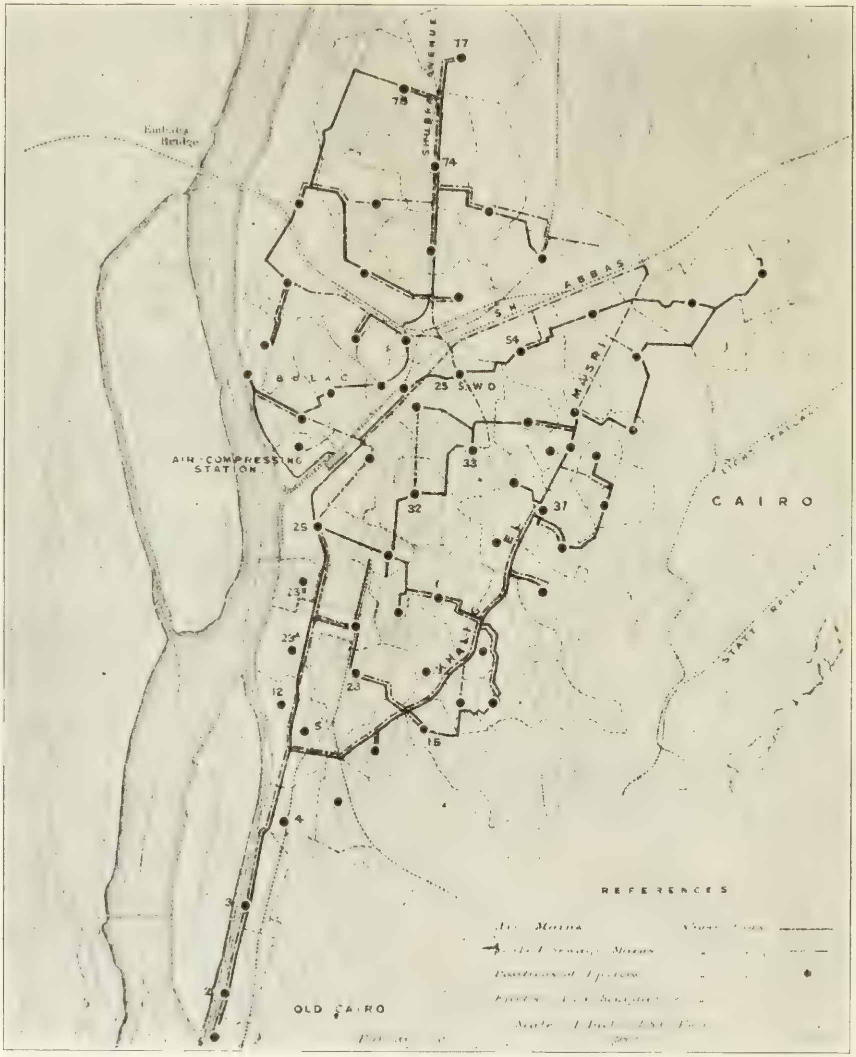
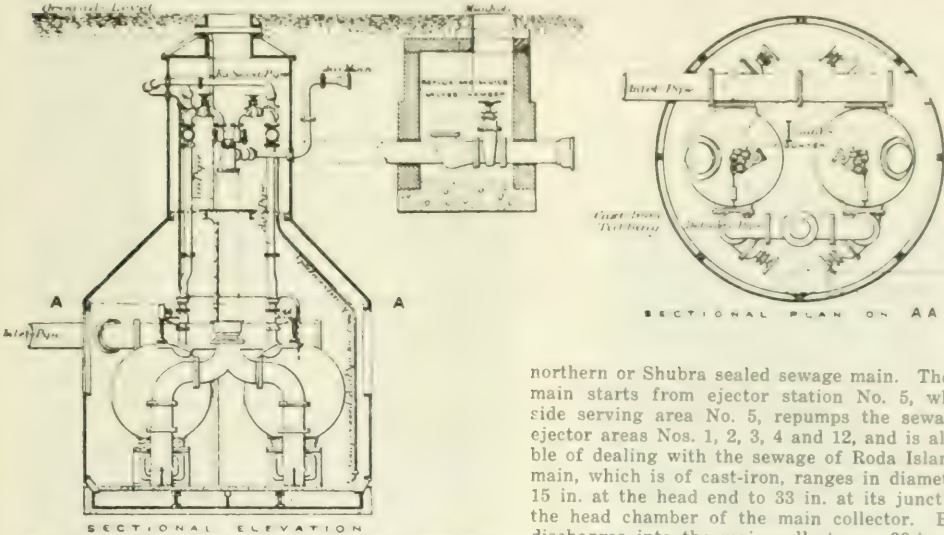


Fig. 1—Layout of the Main Sewer System of Cairo, Egypt, Showing Location of Ejector Stations.

The ejectors are of the Shone-Ault pattern, manufactured by Yeomans Bros., Chicago. Fourteen stations are fitted with duplicate 50-gal. per minute ejectors; 14 with duplicate 100-gal., 10 with duplicate 150-gal., 16 with duplicate 250 gal., 1 with duplicate

300-gal., 5 with duplicate 500-gal., and 3 with triplicate 500-gal. ejectors.



SECTIONAL ELEVATION

SECTIONAL PLAN ON AA

Fig. 2—Typical Arrangement of Ejector-Station With Top Entrance.

All ejector stations are entered from the top except two, namely, Nos. 33 and 37. Number 33 is in the Ezbeia Garden, the principal public garden of Cairo. Here the cast-iron tubbing has been enlarged and lined with white tiles, and a spiral staircase gives access to it from the ground level. It is surmounted by an ornamental building in brick and stone and is open to inspection by the public. Station No. 37 is situated in the Sharia Mousky, the busiest street in Cairo, and a side entrance has been provided in this case to facilitate inspection and avoid interference with traffic.

The compressed air for the ejectors is supplied through cast-iron mains, which are laid in circuits and controlled by air valves to insure a continuous supply, should a rupture or leak necessitate the shutting down of any particular length. The condensed water draw-offs are U-tubes tapped into the main at its invert and carried to the surface of the road, where a tap is fitted through which the condensed water is expelled into the street by the air pressure in the main. The exhaust air is discharged from the ejector into a silencing chamber consisting of 24-in. diameter cast-iron pipes connected to a ventilation column 35 ft. in height, and varying from 9 in. to 12 in. in diameter. The silencing chamber is laid at a gradient, and any moisture carried by the exhaust air is drained back to the inlet manhole through a $1\frac{1}{2}$-in. diameter galvanized iron pipe. The pipes used are 12 ft. long, of the ordinary spigot-and-socket pattern, and 1, 2 or 3 pieces were used, according to the capacity of the ejector station. The ends are blocked with concrete, and the exhaust pipes from the ejectors and the connection with the ventilation column are placed centrally in the concrete mass.

All sewage and air mains have been laid with a minimum cover of 3.28 ft. and have generally followed the surface levels of the roads. Wherever possible, the air mains have been laid under pavements away from the heavy traffic.

The compressed air is supplied automatically to each ejector on its being filled with sewage, and the contents are displaced and passed to the main collector through cast-iron sealed sewage mains ranging from 6 in. to 33 in. in diameter. There are three distinct arteries that serve the whole system, namely, the eastern or Khalia sealed sewage main, the western or Sharia Abbes sealed sewage main, and the northern or Shubra sealed sewage main. The Khalia main starts from ejector station No. 5, which beside serving area No. 5, repumps the sewage from ejector areas Nos. 1, 2, 3, 4 and 12, and is also capable of dealing with the sewage of Roda Island. This main, which is of cast-iron, ranges in diameter from 15 in. at the head end to 33 in. at its junction with the head chamber of the main collector. Before it discharges into the main collector, a 33-in. Venturi meter is installed in an accessible chamber. The throat of the meter is submerged, a drop of 5.57 ft. being allowed on a 164-ft. break in the regular gradient of the main.

The western, or Sharia Abbas, main starts from ejector station No. 25, which repumps the sewage of ejector stations Nos. 23, 23-A and 23-B. This main, which ranges in diameter from 14 in. to 18 in., discharges into a 30-in. gravity main at ejector station No. 23 S D W. The gravitation main is laid at a gradient of 1 in 1,500 and is enlarged from 30 in. to 33 in. The diameter of 33 in. is maintained up to the Venturi meter at the junction of the Shubra main, after which the discharge from both is conveyed by a 45-in. circular brick-lined concrete culvert, 310 yd. long, to the head chamber of the main collector. A drop has been made between the invert of the 33-in. main and 35-in. culvert for submerging the throat of the Venturi meter.

The northern or Shubra main starts at ejector station No. 71 with a 9-in. pipe and is gradually enlarged to 15 in. after the junction with ejector stations Nos. 74, 77 and 78. On leaving the Shubra road the diameter of 15 in. is increased by several stages to 33 in. at the point where the main joins the chamber on the 45-in. brick-lined culvert.

No Venturi meter has been fixed on this main, but provision has been made for inserting one when required. Shubra is not as yet fully developed, and the sewers in this area will be the last to be laid.

All sewage mains 10 in. or less in diameter have intersection openings at all bends and at every 220 yd. of straight piping. The openings have an internal diameter of 3.28 ft. and are perfectly water-tight. The covers are securely bolted down.

Sluice valves are provided at all junctions to enable any ejector station to be cut off from the mains, and immediately outside all stations a chamber containing a further sluice and reflux valve is provided.

The sealed sewage mains were tested to a hydraulic pressure of 50 lb. per square inch, maintained for 15 minutes without loss or visible leakage. The test for air mains consisted in applying an air pressure of 50 lb. per square inch which pressure was not allowed through leakage to drop below 45 lb. during one hour. These tests were applied length by length, and the whole system was again finally tested on completion.

## Method of Determining Most Economical Size of Water Main for Given Condition

In trying to hold the balance between first cost and maintenance charges in colliery management, D. M. Mowat has worked out in Transactions of the Institution of Mining Engineers, Vol. LIV, Part 4, the details of one of its most vital problems. Since the scheme was devised some years ago, the prices, and so on, are not of value today, but the system is interesting and has provoked discussion.

The problem was this: What is the most economical size of pipe to convey by pumping 1,000 gal. of water per minute to a distance of 2,400 ft.? The road in which the pipe was to be laid was a good road arched throughout, and there was accordingly no question of increased cost on account of maintenance of the roadway, etc. The factors to be taken into account were, therefore (a) cost of pipe-line, including installation; and (b) loss of head and power, on account of friction, and the cost involved in overcoming this loss, capitalized. In estimating the frictional loss the writer used Rankine's formula, viz.: The loss of head, in feet $= \dfrac{\text{length in feet} \times G^2}{213{,}000{,}000 \times d^5}$, when $G =$ gallons per minute and $d =$ diameter of pipe in feet.

In estimating the power required, the writer has assumed an efficiency of 66⅔ per cent. In calculating the monetary value of the frictional losses, he has used a capitalized value of £60 per electrical horsepower. Probably this figure will be considered very low.

TABLE SHOWING THE RELATIVE LOSSES DUE TO FRICTION IN PIPES OF VARIOUS SIZES.

| Diam. of pipe. | Weight of pipe, per ft. | Weight of 2,400' of pipe-line. Ton. | Cost of pipe-line at £5 per ton. | Loss of head due to friction of water in pipes. Feet. | Electrical H.P. due to friction in pipe-line: $\frac{h \times G \times 10 \times 1\frac{1}{2}}{\text{E.H.P. } 33{,}000}$ | Capitalized value of loss due to friction calculated at £60 per E.H.P. |
|---|---|---|---|---|---|---|
| 8 | 47 | 50 | 250 | 85.5 | 38.9 | 2,334 |
| 10. | 60 | 64 | 320 | 27.9 | 12.7 | 762 |
| 12 | 82 | 88 | 440 | 11.25 | 5.1 | 306 |
| 14 . . . | 105 | 112 | 560 | 5.22 | 2.37 | 142 |
| 16..... | 123 | 132 | 660 | 2.67 | 1.21 | 72 |

| Cost of pipe-line plus capital cost of frictional losses (running full time). | Cost of pipe-line plus capital, cost of frictional losses (running half time). |
|---|---|
| £2,584 | £1,417 |
| 1,082 | 701 |
| 746 | 593 |
| 702 | 631 |
| 732 | 696 |

If pumping goes on continuously the most economical size of pipe is 1 of 14 in. in diameter, and when pumping half time a 12-in. pipe is the most economical.

## Method of Supporting Underground Workings in the Rand Mines

In two complementary papers appearing in the August, 1917, number of the Journal of the South African Institution of Engineers, Percy Cazalet and G. Hildeck-Smith respectively discuss the support of underground workings in the Rand mines, and the systematic underground packing at the Ferreira Deep Mine.

Mr. Cazalet leads up to modern methods by outlining former theories and practices. It was once believed, he says, that the quartzites of the Rand would, as the phrase went, "arch themselves naturally" by successive cavings, and that the disturbances of subsidence would reach the surface only when shallow excavation was involved. But this view has been dispelled by the appearance of large surface cracks whose origin has been definitely traced, in some cases, to points 1,200 ft. to 1,500 ft. underground.

**Sand-Filling.**—Sand-filling has been the most generally useful of the modern methods, but for two reasons it cannot be used as the chief support of the heaviest mines: (1) it is difficult to apply to current stopes simultaneously with the advance of the faces and close enough to prevent the caving in and sagging of the hanging-wall in the space between the sand-filling and the face; (2) the great depth of future workings will render increasingly difficult the lowering of the sand and dealing with the water which must be used for its transport.

In mines not subjected at the time of filling to excessive weight, sand-filling is satisfactorily used as support to the hanging-wall where ore has been mined over large areas; the hanging-wall then settles in a mass and the filling controls and minimizes the settlement.

**Methods of Supporting Hanging-Wall.**—There remain three chief methods of supporting hanging-wall in such close proximity to the working faces as the heaviest mines require.

(1) The packing or stowage of waste rock which is either broken during development or especially broken for the purpose. Its drawback is due to the layout usual to such mines and to difficulties caused by the angle of dip when it lies between 15° and 40°.

(2) The square-set method of timbering, which is quite unused on the Rand because of the absence of local timber and the high cost of imported timber and skilled labor.

(3) The use of round timber for props, stulls and pig stys, which, especially in the last form, are solving some of the difficulties of the hanging-wall problem at reasonable cost. These must, of course, be filled with waste or reef to be of the least use except for momentary purposes.

(4) The packing of ore actually broken at the stope face.

The last, in Mr. Cazalet's opinion, is the only method which entirely meets the requirements in workings where the angle of dip does not exceed 60°—of such conditions of weight as exist in modern mines.

Some of the indirect advantages of this system of support follow: Pillars need not be cut; the controlled "weight" assists in the breaking of the ore; fails of hanging-wall which would impede stoping operations are prevented; broken ore is concentrated in limited areas, as the packs prevent the scattering of ore when blasting takes place; time is saved in barrigging and dismantling or repairing tracks, shoots and pipe lines; and the probabilities of accidents are minimized.

Mr. G. Hildeck-Smith summarizes as follows the various methods of packing in stopes of the Ferreira Deep Section.

**Packing in Typical Main Reef Leader Machine Stopes of Average Stoping Width of 75 In.**—In this class of stope the hanging-wall is usually so bad as to necessitate building packs within from 6 to 8 ft. of the machine benches. The packs are built of broken ore from the current stope faces, and are supported first by timbers and lagging poles. The foundation timbers are about 10 in. in diameter and 10 ft. apart, carefully placed in hitches but without headboards. These timbers are set in such a way as best to withstand the shock of blasting. Lagging poles, 12 ft. long by 3 in. in diameter at the small end, are placed across the timbers, beyond which they project about 1 ft. They are placed about 12 in. apart to allow for "wings," a lateral extension to the original pack formed by placing lagging poles over one of the stull posts of the original pack between the ends of its lagging poles and over a new timber placed as required, this widening the pack foundation and continuing the packing off the new extension. It is important that the backwall of the pack be so built that when the timbers and lagging poles fail or are removed, only the filling falls away. A great advantage of this type of pack is that timbers and lagging poles can be withdrawn and used over again.

In building packs of this type, the back and retaining walls should be commenced with the main footwall as a foundation and not built on loose, broken rock. The farther retaining wall should always be built up ahead of the one nearer the face, thus the rock from the blast is shot into the pack. This sort of pack is most satisfactory where there is heavy blasting, and in stopes dipping at 10° to 35°

**Packing in Main Reef Leader and South Reef Stopes of an Average Stoping Width of 65 in.**—The work in this class of stope is generally done by small machines or hand labor, with a view to saving time and timber. Pig stys are built either of square or round timber 8 ft. long by 5 in. thick, square timber being the easiest to handle in steeply inclined stopes. The foundation of a pigsty consists of two lagging poles set as stull pieces; by the time these poles are broken by the subsidence of the hanging-wall, the pigsty has been tightened sufficiently to stand by itself. Near stope-faces they are protected by stacked ore as a buffer against blasting.

Where packing is not subjected to blasting pigsties of old timber or packs of waste rock only are generally used to support hanging-wall.

**Pipe Lines and Intermediate Tracks.**—Systematic packing facilities stope watering and the supply of compressed air to the machine stopes, as pipe lines are placed through the stopes away from the stope face and behind the packs so that pipes are rarely put out of order by blasting. Down the stopes from the pipe lines, horizontal branch lines are connected and extended to the stope faces. Intermediate tracks are laid between the packs 50 ft. apart through the stope. On these the ore is trammed at fixed footwall chutes. This is the most efficient means of removing broken ore from a stope of 29°, but packing makes intermediate tracks on this angle of dip still more efficient. In a large machine stope where packs are only 10 ft. from the face and a bench has been blasted between the pack and the face, the quick clearing away of the broken ore is facilitated by small trucks run close to the face, so that bar-rigging can be begun sooner.

The good results obtained from these various methods of packing for the support of the underground workings of the Rand mines is now more fully appreciated, and it is more usual to find conditions approaching those than the Ferreira Deep. A point which should not be overlooked is that once having begun ore-packing it is essential that enough be done to make the reclamation of the packs possible. This can be hoped for if packing is curtailed to maintain uniform monthly output.

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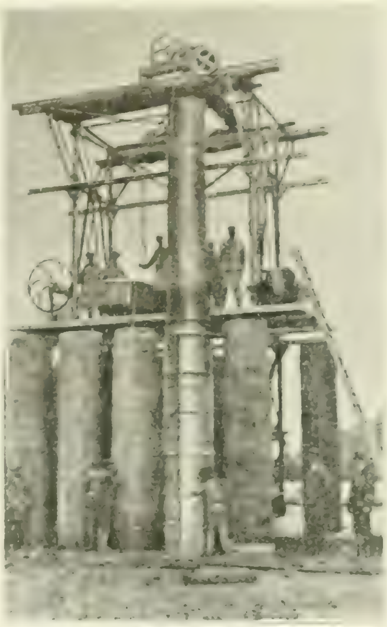
## Bonna System Reinforced Concrete Pipes in Antwerp Waterworks Extension

[illegible]

In 1912 it became necessary to increase for the second time the size of Antwerp's water works. After careful investigation the Bonna System of reinforced concrete pipes was adopted. These pipes consist of a steel liner 2 mm. thick, acetylene welded at the circumferential and longitudinal joints and reinforced internally and externally. The outer reinforcement is of 10 mm. steel rod, wound spirally around the liner with a pitch of about 75 mm. It is kept clear of the liner by rods of 4 mm. diameter, spaced every 10 cm. around its circumference. The internal reinforcement is merely to hold the internal cement, and is formed of a 4 mm. steel rod wound spirally with longitudinal rods of the same diameter arranged as in the external reinforcement. The reinforced liner is placed in a vertical mould and the pipes cast from the platform of a traveling gantry. The mixture used is half Rhine sand, [illegible] Portland cement and [illegible] "Porte de France" (a special, quick-setting cement); the moulds can be removed in about 20 minutes. The



Making Pipe by the Bonna System.

ends of the steel liners are left uncovered for a length of 10 cm. when casting the pipe and the joints are made by butting these ends and placing a steel band around them. Yarn, soaked in bitumen, is caulked into the band and the joint is finished with lead tubing filled with yarn; a ring of reinforcement is then slipped in place, and the joint cast solid in cement.

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# Causes of Spontaneous Combustion of Waste

By JAMES SCOTT

The Railway Engineer.

Every engineer must know the dangers of undisturbed heaps of oily cloths and cotton waste, and be interested in learning how the condition arises.

At the outset it should be understood that oil or oils include fats, which become oils at specific temperatures; there is no chemical difference between solid and liquid tallow. Many oils are oxidizable, and continually attract oxygen to themselves, and, by intimately uniting with it, thicken or dry. This is the dangerous quality upon which much of the risk of spontaneous combustion depends. Linseed oil, for example, will oxidize to a rubbery consistency. But many of the ordinary lubricants and cleaners commonly regarded as non-driers and presumably devoid of the power of gumming or clogging, are liable to the same results in a less degree. Mixed oils, although often of a permanent constitution in normal use, are often mixed with others which alter considerably in this direction. Pure oils are rarer than the engineer supposes, from the easy way in which he specifies "pure oil." But non-oxidizable oils give rise to combustion more slowly, although the final effects are as dangerous as those due to more sensitive varieties.

Most animal and vegetable oils used as lubricants or cleansers are composed of particular fatty acids—butyric, valeric, lanric, stearic, linoleic, ripic, oleic, and in combination with glycerin, and are consequently known as glycerids. Exceptions such as fish or sperm oil, largely composed of combined monohydric alcohols and oleic or doeglic acids, need not be closely considered, as this article deals generally with the subject. As a whole, most have carbohydrogen and oxygen in their constitution, and when decomposed by natural or artificial means these elements enable combustion to proceed quickly. The elaborate gases thus formed are very inflammable and cause a continuous spread of fire if not checked. Spontaneous combustion may begin insignificantly and not become noticeable for a long time.

Carbon, when sufficiently heated, burns in air to carbonmonoxide, which adds to its power, while the hydrogen is capable of ready ignition, and oxygen supports and aids combustion. Excess oxygen forms carbon dioxid, which is non-inflammable and would temporarily suppress flame. But the modifications are so delicate that they may suitably dispose themselves for ignition. The products of greasy disintegration are thus favorable for the development of fire.

Glycerin is alcohol, technically known as glycerol. When heated it completely vaporizes, leaving no trace of residue or soot. It has been proved that when some oils turn rancid the glycerin content is greatly reduced, and yet it has been found impossible to trace its method of disappearance. It seems reasonable, then, as it does not enter into new combinations, that it is slowly evaporated and lost.

Mineral oils do not like oxygen. Indeed, so immune are they from its presence and from the power of attracting it that the chemist habitually preserves in them any substance (like metallic sodium or potassium) from which it is absolutely necessary to exclude oxygen.

But oils of this sort vaporize naturally, and at certain temperatures, or "flash points," these fumes become ignitable. Ordinarily, unless highly concentrated, they are quite safe. But when used in combination with oxidizable oils, their vapors may add to the dangers of sudden firing. Many believe that a mixture of animal or mineral oils is safer than either alone. This may be true, but it is almost certain that beyond that limit the vapor of the mineral oil hastens combustion.

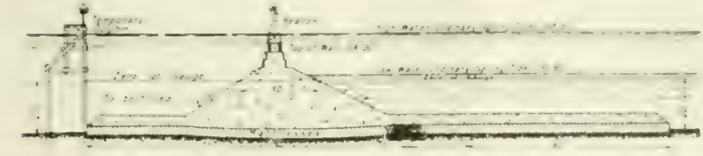
There is every reason to justify the conclusion that aerobic bacteria and bacilli exert a strong influence upon bringing about spontaneous combustion. They excrete or develop enzymes which ferment the oil into a rancid condition, thereby decomposing into simpler forms. That germs can enormously increase the temperature of organic refuse is seen in the steaming hotbeds of manure. The water, moisture and ammonia check ignition. In automatically heated haystacks, for example, the dry alcohol evolved from the packed starches, gums and sugars in the stalks ignites and the whole afterward flares. An abundance of stagnant air is necessary before spontaneous combustion can take place. This would seem to be absent from dense piles of cotton waste and kindred stuffs, but, as a fact, fibrous arrangement facilitates its dispersal among the fibers and retention. However compact they look, they are entangled with air held in the small cavities formed by their interlacing. The oil contracts into beads at intervals along them; and when these beads meet they produce curved films which bridge the fibers. The mass, therefore, consists of a system of separated, thin oil membranes, surrounded by a plentiful supply of air. Undisturbed chemical and microbic activity decomposes the animal or vegetable oil and releases the inflammable vapors into the spaces. There is a corresponding increase in temperature, and if this is favored by artificial warmth in the vicinity the changes are hastened. A minute portion of the mass may ignite and gradually extend the mischief until the whole lot is involved and visible flames appear. The fibers feed the combustion and it hardly matters what their nature is. Cotton is commonest, yet waste silk may be used; this is even more liable to ignite. Hemp and jute are, like cotton wool, nearly as bad as silk. In my experiments I used cotton waste soaked in olive oil, and olive oil with mineral oil. There was little actual difference between the detectable results of the tests, so the illustrations depict the orthodox behavior. Inferior olive oil, known as gallipoli or engine oil, is sold for lubrication or cleaning. Most engineers shun it, but the best makes an excellent locomotive oil.

When greasy cotton waste remains in a glass vessel at a fairly high temperature, it ignites without the contact of naked flame. After ignition the charred fibers are shrunken and friable, with black globules indicating the residue of the consumed oil. Upon the glass will be found small patches of opaque white fat, minutely crystalline, which are the fatty acid matter previously in combination with the mobile fluids. There are also peculiar meshes consisting of globules inside one another, which give a clue to the way in which gases percolate through denser substances.

# The Rangoon Training Wall

On Feb. 17, 1914, the future of the fine port of Rangoon was assured by the completion of a training wall 10,000 ft. long extending from above Rangoon to within 2,000 ft. of Mower's Point, opposite the city.

For years the business of the port has been threatened by the fact that the river, which is the chief channel of its trade, was leaving the town, and that sand banks were forming in hitherto valuable reaches. Just above the city the river changes its course at almost right angles. The 4 to 6-mile current gradually eroded a channel on the outside of the bend away from the city. At one place opposite Rangoon, too, one point offered such resistance that the flow deflected diagonally across the bed toward wharves and quays which it bade fair to destroy.



Section of Rangoon Training Wall.

In 1901, Mr. G. C. Burnham, C. I. E., M. Inst. C. E., first seriously took the matter in hand. For some years the prosecution of the remedy was delayed by a difference of opinion as to means, but in 1910 the scheme, slightly modified, received the sanction of the Government of India.

It was proposed to dredge a channel in front of the wall, whose top would be 5 ft. above low water of springtides. The river bed along the wall line is fine sand and silt from 6 to 10 ft. thick, overlying gravel. The wall cuts off a 300-acre area which is now silting up at the rate of 3 ft. per month, and will eventually be reclaimed.

The wall stands on a mattress base 230 ft. wide. This floor was composed of 225 mattresses each 125 ft. long by 75 to 80 ft. broad and 3 ft. thick. They were constructed of 5,500,000 brushwood bundles, together with 53,000 bundles of stakes. The mattresses were put together on specially constructed slipways, and they had to be made while the slipway was uncovered at low water. From 250 to 300 men were employed for 5 to 7 hours on each mattress. As the tide rose the mattress floated; a bamboo boom was placed under one edge and tugs towed the mattress to the site.

There the mattress was brought into position between four circular pontoons and arrangements were made for guiding the mattress, as it sank by ropes attached to the anchors. Then stone from the barges on either side was deposited by coolies on the mattress from the middle outwards. When the sinking of the mattress permitted, the barges were moved above it, and as rapidly as possible deposited the stone. Only 80 tons were needed to sink a mattress, but about 300 tons were always used. This amount was placed by 120 to 150 men in 20 minutes.

The stone, of which over 1,500,000 tons have been used, was mainly granite obtained from the Island of Kalagouk, which is 135 miles distant from Rangoon in the open sea. This island was uninhabited, covered with tropical vegetation and had a rainfall of 200 to 260 in. in the year. The quarries had to be opened up, piers built and quarters arranged for 1,000 employes. Complete hospital equipment, military police, post office and cable to the mainland had to be provided, and a pier built in deep water from which two cableways carrying skips accommodating 7 tons of stone connected with the shore. The steamers were moored inside the pier and the stone deposited direct into the holds from the skips.

It was originally intended to leave the wall at a level of 5 ft. above low water, but the water fell over the wall with such force as to result in a great deal of scour at the back, where it was desired to induce natural situation. The wall was therefore raised 9 ft. by means of reinforced concrete cribs 3 ft. square, tied by iron rods and filled with loose stone. It was found that natural scour so rapidly deepened the channel that dredging was unnecessary.

The cost, including the superstructure, was £920,000; the estimated cost was £1,000,000. The force employed averaged about 2,500 men. The work was finished in 4 years exactly, 1¾ years less than the estimated time.

# Rail-Creep

By FRANK REEVES, M. Inst. C. E.

[illegible]

The author began his experiments to determine the cause of rail-creep by passing a wooden wheel several times in succession, in one direction, over a planed white pine lath resting on a hardwood bench, and found to his surprise that the lath had moved bodily about 2 millimeters in the direction of travel, the total amount of the latter having been about 14 meters. Up to that time the author, in common with many other railway engineers, had held the opinion that creep was probably due to temperature changes, assisted by the movement of trains.

After a further series of experiments, he reached the following conclusions:

(1) Creep of rail is due primarily to deformation of the rail as the wheel passes over it. It may be likened to the movement of dough when rolled under a rolling-pin.

(2) The more violent the deformation, the greater the creep. That is to say, that creep is increased by

(a) Increasing the wheel-load;

(b) Diminishing the rigidity of the rail, by either reducing its section or using a weaker material.

He then sets out in detail the evidence in support of these conclusions, and proceeds to discuss the influences of various factors as follows:

Weight of Wheel. This appears to be the most powerful factor affecting the amount of creep.

Rigidity of Lath. In every case the creep was much greater with the lath on the flat than with the same lath on edge.

Continuous versus Intermittent Support. With the pine lath the creep is always greater—from twice to four times—when the lath is supported on sleepers resting on the naked bench. The effect was heightened when the lath was on the flat as compared with on edge, which again bears out the theory that creep is an effect of deformation in the rail.

Yielding of the Support. From the experiment with the pine lath, the general conclusion is that interposing a strip of rubber between the bench and the lath made little difference, even reducing the creep, if anything (except in one case with a heavy wheel on a lath on the flat). It would appear that with a light wheel-load and a rigid rail the yield of the road-bed has little effect; but that with a heavy wheel-load on a flexible rail the creep is decidedly increased by a yielding road-bed.

The author finally comes to these views as to the cause of rail-creep: It is caused primarily by deformations of the rails under the rolling loads, assisted by temperature changes, which cause fish-joints to slip and lessen the resistance. Where track is on a yielding road-bed, creep is intensified, especially under heavy wheel-loads. It is also accentuated by braking, in places where regular stops are made. Creep is greater down-hill than up-hill, but it is by no means absent on the latter. It is usually asserted to be worse in hot weather than in cold. Creep is always with the traffic. On single track lines there is normally no trouble with creep. But if there is a preponderance of traffic in one direction, more or less creep takes place in that direction. Creep may be resisted by putting in enough anchorage.

# Industrial Housing Schemes of Dundee

From an article by James Thompson, City Engineer and Architect, in The Surveyor and Municipal and County Engineer

The following schemes for the housing of the working people of Dundee embody several features of unusual comfort, sanitary advantage and economy. Each scheme took its name from a park district so nearly adjoining the central industrial area as to be readily accessable and yet be in an open and healthful locality.

Instead of continuous ranges of tenements immediately on the streets, with infrequent openings, the proposed tenements are planned in short lengths with large open spaces in front, in rear and at the ends of blocks. As far as land levels permit, all tenements are so placed that the sun reaches during a part of every day the windows of all living rooms. The erection of wash houses and cellars, usual on the back space of tenements, has been entirely omitted, and the land kept free from out-buildings, boundary walls and similar obstructions.

Space is provided for garden allotments, and areas reserved for children's playgrounds. An important departure provides land on which wash houses and baths may be erected for the use not only of the occupants of the new houses, but for the convenience of other householders of the neighborhood. In addition, since the schemes aim to benefit equally those who occupy the smallest houses as well as the largest, land is provided in each project for the erection of a day-nursery.

Save where exceptional surroundings warrant three stories, the height of tenements is limited to two stories; there are to be no ash-pits, and the special system of ashbins is provided for removing house refuse. No separate wash-houses and baths will be used, a central building for washing and bathing being substituted. It is suggested that a central heating and hot water supply might be there installed, to economize fuel, to convenience the occupants and abate the smoke nuisance.

Mr. Thompson recommends that effort be made to obtain land at such a price that the annual charge on each tenement will be only slightly in excess of 10 shillings. At this rate, on the basis of 20 houses to the acre, the price payable at 20 years' purchase should not be more than £200 per acre.

In preparing the statement (a) interest is calculated at 5 per cent per annum; (b) the loan period is taken at 60 years; (c) the system of repayment is by equal annual installments of interest and principal combined, amounting together to £5 5s. 8d. per cent; (d) the cost is taken at probable post-war rate, standardizing of parts, simplicity in design, and economy in construction being aimed at; (e) a grant in aid by the state is assumed at 25 per cent of the cost of the buildings only; (f) no property tax is chargeable; and (g) the rent payable includes tenants' rates, garden allotment, house furnishings and 6d. per week for the use of baths and wash-houses and for the supply of hot water to kitchen-scullery and radiator to living room.

STERLING PARK SCHEME.

Expenditures.

| | | £. | s. | d. |
|---|---|---|---|---|
| Cost of buildings | £58,000 | | | |
| Less proposed grant in aid | 14,500 | | | |
| £43.500 at £5 5s 8d per cent. | | 2,298 | 0 | 0 |
| *Owners' and occupiers' rates, £2,453, at 6s 9d per £ | | 828 | 0 | 0 |
| Repairs, management, etc., on net rental, £2,453, at 10 per cent | | 245 | 0 | 0 |
| Fire insurance, £40,000, at 1s 6d per cent | | 30 | 0 | 0 |
| Payment to baths and wash-houses department, 172 houses at 6d per week | | 224 | 0 | 0 |
| Total expenditures | | 3,625 | 0 | 0 |

Revenue.

| | £. | s. | d. |
|---|---|---|---|
| 6 houses of living-room and kitchen-scullery, at 6s 6d per week | 101 | 8 | 0 |
| 124 houses of living-room and kitchen-scullery and bedroom, at 8s per week | 2,579 | 4 | 0 |
| 42 houses of living-room, two bedrooms and kitchen-scullery, at 9s 6d per week | 1,037 | 8 | 0 |
| Total revenue | 3,718 | 0 | 0 |

SPRINGFIELD SCHEME.

Expenditures.

| | | £. | s. | d |
|---|---|---|---|---|
| Cost of buildings | £168,000 | | | |
| Less proposed grant in aid | 42,000 | | | |
| £126,000 at £5 5s 8d per cent. | | 6,657 | 0 | 0 |
| *Owners' and occupiers' rates, £6,765, at 6s 9 d per £ | | 2,283 | 0 | 0 |
| Repairs, management, etc., on net rental, £6,765, at 10 per cent | | 676 | 0 | 0 |
| Fire insurance, £120,000, at 1s 6d per cent | | 90 | 0 | 0 |
| Payment to bath and wash-houses department, 479 houses, at 6d per week | | 623 | 0 | 0 |
| Total expenditures | | 10,329 | 0 | 0 |

Revenue.

| | £. | s. | d |
|---|---|---|---|
| 20 houses of living-room and kitchen-scullery, at 6s 6d per week | 338 | 0 | 0 |
| 362 houses of living-room, 1 bedroom and kitchen-scullery, at 8s per week | 7,529 | 12 | 0 |
| 97 houses of living-room, 2 bedrooms and kitchen-scullery, at 9s 6d per week | 2,395 | 18 | 0 |
| Total revenue | 10,263 | 10 | 0 |

LOGIE SCHEME.

Expenditures.

| | | £. | s | d |
|---|---|---|---|---|
| Cost of buildings | £110,000 | | | |
| Less proposed grant in aid | 27,500 | | | |
| £ 82.500 at £5 5s 8d per cent. | | 4,359 | 0 | 0 |
| *Owners' and occupiers' rates, £4,466, at 6s 9d per £ | | 1,507 | 0 | 0 |
| Repairs, management, etc., on net rental, £4.466, at 10 per cent | | 446 | 0 | 0 |
| Fire insurance, £80,000, at 1s 6d per cent | | 60 | 0 | 0 |
| Payment to baths and wash-houses department, 314 houses, at 6d per week | | 408 | 0 | 0 |
| Total expenditures | | 6,780 | 0 | 0 |

Revenue.

| | £. | s | d |
|---|---|---|---|
| 12 houses of living-room and kitchen-scullery, at 6s 6d per week | 202 | 16 | 0 |
| 228 houses of living-room, 1 bedroom and kitchen-scullery, at 8s per week | 4,742 | 8 | 0 |
| 74 houses of living-room, 2 bedrooms and kitchen-scullery, at 9s 6d per week | 1,827 | 16 | 0 |
| Total revenue | 6,773 | 0 | 0 |

SUMMARY.

| | |
|---|---|
| Cost of buildings, less grant in aid, 3 schemes, 965 houses | £252,000 |
| Estimated annual expenditure, 3 schemes, 965 houses | 20 734 |
| Estimated annual revenue, 3 schemes, 965 houses | 20 754 |

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*Note—Rents have been fixed at such rates as will enable revenue to meet expenses.

# Compound Type of Breakwater at Gibraltar

Minutes of the Institution of Civil Engineers

The need for safe anchorage for vessels in all weathers, as well as for equipping the Empire's fortress that guards the entrance to the Mediterranean, brought about the extension of the dock yards and enclosure and the defense of the Gibraltar Harbor under the Naval Works Act of 1896, '97, '99, 1901, 1903 and 1905. The works included a detached breakwater 2,720 ft. in length, located between the north and south breakwaters.

In order to start the blockwork of the breakwater, a steel caisson with sloping ends and of the following dimensions was adopted:

| | Ft. | In. |
|---|---|---|
| Length, moulded, on bottom | 191 | 2½ |
| Length, moulded, on top of fixed part | [illegible] | 10½ |
| Length, moulded, portable bulwarks | 72 | 10½ |
| Breadth, moulded | 33 | 0 |
| Depth, moulded, of fixed part | 37 | 6 |
| Height of portable bulwarks | 11 | 6 |
| Length of wall, moulded | 60 | 0 |

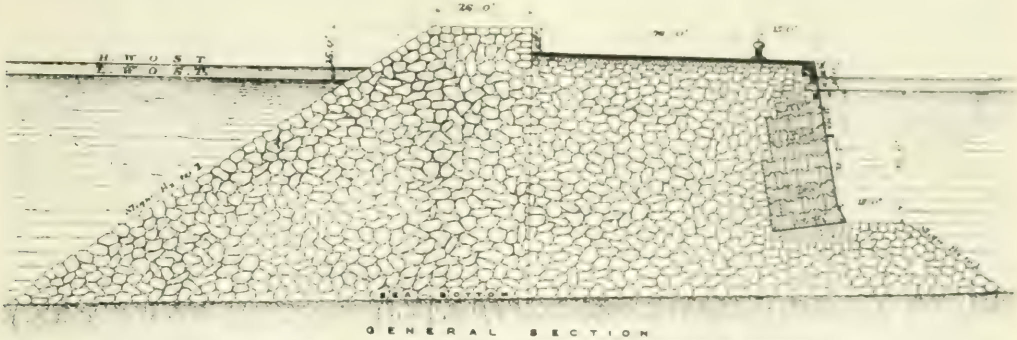
The angle of the sloping ends was 70°, the angle at which the blockwork was laid, while the breadth of the caisson, 33 ft., also agrees with the width of the blockwork of the breakwater. The blocks touching the caisson were grooved to suit angle-bar projections.

The detached breakwater is of the compound type, with a rubble-mound base and a vertical wall superstructure of concrete blockwork which is finished above high-water level with ashlar masonry and mass concrete. The ruling width of the blockwork is 33 ft., and the diameter of the heads 61 ft. on the top. The quay level is 11 ft. above low water and the parapet 15 ft. 6 in.

The sea bottom is sound, and the depth of water over the site ranged from about 45 ft. at the south end to about 65 ft. at the north end; on the seaward side of the breakwater this increased rapidly.

The rubble mound with slopes of $1\frac{1}{2}$ to 1 was brought up to a level of 36 ft. below low water, equal to 36 ft. 9 in. below ordnance datum, except at the heads, where it was kept 5 ft. 6 in. lower. Before any blocks were set the top of the mound was carefully trimmed and leveled by divers with selected small material, and on the surface so prepared the block was set on the sloping system (except in the heads), the angle of inclination being 70°. The top of the blockwork (lower angle) lay at a level of about 7½ in. above high water.

Two 36-ton cranes, each with a radius of 75 ft., were employed for block-setting. One was first erected on the caisson, and having worked its way southward, made room for the second, which worked northward.



General Section of Compound Type of Breakwater Constructed at Gibraltar

The caisson, which was of mild steel, was divided longitudinally into 5 main compartments, but the two end divisions were subdivided crosswise into three, making 9 compartments in all; of these the three at each end were watertight, while the others formed a central well without a bottom.

On reaching Gibraltar in pieces the caisson was partially re-erected on the foreshore in the dockyard, launched in an incomplete state owing to the small depth of water at the site, completed in the water, and ballasted, chiefly with burr concrete, to a uniform draft of 32 ft.

The center of the caisson lies at a distance of about 1,116 ft. from that of the North Head, and after the bed had been carefully prepared and leveled by divers, the caisson was towed out to the site and carefully moored into exact position, there being then a clear depth of 4 ft. at low water underneath. It was then sunk on its permanent bed, and finally filled with concrete up to a height of 11 ft. above low water.

The weight of the hull when launched was about 280 tons, which was increased, when it was completed and ballasted, to a draft of 32 ft., to about 964 tons. After the final concreting the whole formed a monolithic mass of about 8,884 tons.

Concrete bagwork was used for making up the sloping beds or footings for the blocks, and particular care was taken that each block was accurately bedded in such a manner that there should be no tendency to slip away at the bottom from the course previously set. The concrete for the bagwork was of quality A, and was hand-mixed close to the spot where it was used. The bags of concrete were laid by divers, in regular transverse courses, closely packed, and well pressed down. The bags were of jute, strongly sewn, and about the size of an ordinary cement bag; about a dozen bags at a time were lowered to the divers on a special cage or tray.

The concrete blocks throughout the breakwater were keyed with concrete joggles, and no joints wider than ½ in. were allowed.

The blocks in the round-heads were laid horizontally, the bottom course on a bed of concrete. The circular face-blocks were accurately moulded with radial joints and were tied back to the mass work and hearting blocks with wrought-iron clamps 3½ in. x 3½ in., turned down 1 ft. 6 in. at the ends. Special blocks were made for forming the junctions between horizontal and sloping work. The concrete for all blockwork was of quality D.

The top course of sloping blocks and the corresponding course of horizontal blocks in the heads were faced with limestone ashlar, and the coping, as well as positions of valves and inspection openings, have been marked in the usual way.

## The Worcester, England, Experiments with Activated Sludge Process

The Surveyor and Municipal and County Engineer.

It has been said that the sludge problem is the sewage problem, and that the solution of one is the settlement of the other. It seems as if the Worcester (England) experiment has gone a step farther to prove that the activated sludge process is the solution of the sewage disposal problem.

At all events, the resulting sludge is an innocuous material and may be deposited anywhere without offense. That the activated slude does possess important fertilizing properties is unquestionable, but the manner of applying it economically to the land is still uncertain. Simple air-drying for a few weeks in very thin layers is suggested, then conveying by mechanical traction to the land within profitable distances. No offensive smell whatever has been observed from the sludge when spread out in this manner. It soon becomes stiff enough to handle, but if allowed to accumulate to any depth it holds the moisture very tenaciously. If this method of application proves practical it will aid enormously from the viewpoint of the production of food crops.

The character of the Worcester sewage is an average one from the domestic and manufacturing point of view. The city is entirely water-closeted, most of the surface water is separated from the sewers, and the variety of manufactories includes breweries, porcelain works, glove works, tanneries, chrome leather works, foundries, engineering works, tinplate works and others.

The experiment is an adaptation of the continuous percolating filter to the matter of sewage purification, and was made by the firm of Jones & Attwood, who agreed to take two-thirds of one of the tanks of the Salford Sewage Works, alter it as they thought necessary, and try out their theories. If not successful by the end of 12 months, they were to remove their plant and restore the tank to its original state.

The experiment was to be considered successful if, without nuisance or offense, 750,000 gal. per day were treated d w f, or twice that amount w w f, so that the resulting effluent should be incapable of putrefaction, and contain not more than four parts by weight of suspended matter in 100,000 parts of effluent.

The purification was effected by keeping the activated sludge, which held the myriads of oxidizing organisms, in intimate contact with the liquid to be purified, and by keeping the organisms supplied with a sufficiency of oxygen from the air. Hence the more finely the sludge was broken up and the more evenly it was distributed throughout the mass of liquid, the more intimate was the contact between the solids and the liquid.

Nothing seemed so effectual to this end as agitation of the entire mass of liquid and solids by the blowing in of atmospheric air, while this method possessed the further advantage of supplying the necessary oxygen to the organisms.

Detritus and all other heavy matter in the sewage was removed before the liquid passed into the aeration tank. This tank is rectangular, 86 ft. 3 in. by 78 ft. by 18 ft. deep from coping to floor, and has a net capacity, at a depth of 17 ft. 3 in., of 626,000 gal. It is divided into 9 longitudinal bays extending from the inlet channel, which runs across the entire width of the tank to its opposite end, by 8 division walls, 9 in. thick, all the bays having a water communication between them at the lower or outlet end. These bays were subdivided by three transverse walls finally forming 36 rectangular bays, each 21 ft. long by 8 ft. wide and 18 ft. deep. Of these 20 were devoted to aeration, 8 to settlement of the sludge and the remaining eight are out of use.

The arrangement for aeration consists of air pipes laid on the floor of the tank, which is flat, containing perforations for the exit of air spaced about one foot apart. Any material increase in the distance between the air exits was found to result in the settlement of slude on the floor in the intervening spaces.

To increase the intervals and to avoid piling up of sludge on the tank floor, a series of concrete ridges and furrows has been constructed over the entire floor area of the aeration tank, the ridges occupying the spaces on which the sludge would accumulate if the floor were flat. In the furrows porous tiles, or "diffusers," were laid, through which the air is delivered to the liquid.

In the first longitudinal set of bays, which receives the raw sewage, the rows of diffusers, which run across the bay and are 1 ft. in width, are separated by a distance of 5 ft. By these a vertical circulation of water is set up, returning upon itself while the air escapes at the surface. In the remaining aeration bays the distance between the rows of diffusers is increased to 10 ft., thereby reducing the consumption to one-half the former series for a given area of tank. Each row consists of 8 diffusers each 1 ft. square, laid transversely across the bay. The resulting circulation, instead of being local to each row, as in the first longitudinal bay, drives the liquid forward.

Advantage is taken of this to create a horizontal circulation around the contiguous series of longitudinal bays; a portion of the water returns and a portion is taken by the next pair to travel in a horizontal circuit in these.

From these the now oxidized liquid, containing its full complement of suspended sludge, passes into the settlement bays. These 8 bays are formed into four tanks, their floors shaped like inverted pyramids at an angle of 60° from the horizontal. At the apex of each pyramid a sludge lift is provided, consisting simply of a 6-in. pipe, in the bottom of which a stream of air is blown which raises the settled sludge and discharges it into an 8-in. horizontal sludge main, which conveys it into the inlet channel, where it mixes with the incoming raw sewage and returns to the aeration tank, the excess sludge being drawn off and conveyed to sand beds for drying and disposal.

The sludge as it leaves the settling bays contains usually about 95 per cent of water, in addition to a considerable quantity of free water, which rapidly drains away. The purified effluent is decanted from the settling tank into troughs, which convey it to the effluent channel. The total net capacity of the aeration bays affords an aeration period of six hours, with a rate of flow of one million gallons per 24 hours, plus 20 per cent of sludge. The settling bays give a detention of one hour and 40 minutes for the same rate of flow, but without the sludge.

The actual quantity treated per day is 750,000 gal., which gives 8 hours aeration and $2\frac{1}{2}$ hours settlement.

Below is an analysis of the effluent:

| | [illegible] | Sewage effluent* |
|---|---|---|
| [illegible] | [illegible] | Trace |
| [illegible] | [illegible] | [illegible] |
| Solids in solution, after ignition .... | 132.0 | [illegible] |
| [illegible] | [illegible] | Blackening, odor |
| Phosphate | [illegible] | Trace |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | 0.17 |
| Oxygen absorbed in 4 hours ......... | 2.1 | 0.56 |
| Nitrogen in nitrates and nitrites | [illegible] | [illegible] |
| Color | Opalescent | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | Slight |

*Dissolved atmospheric oxygen [illegible]

# Slow Sand and Multiple Filtration

By WALTER CLEMENCE.

The [illegible]

One of the greatest drawbacks to slow sand filtration is the impervious layer of slimy mud deposited on the surface of the filtering medium. Yet since the greater part of the bacteria so deposited are nitrifying organisms and the most active agents in the organic purification of the water, the efficiency of the filter was impaired if the layer was disturbed, so that after its removal the value of the filter was not restored until the film had reformed. The forming of the film is of course accompanied by "loss of head," so that by the time the filter is in a condition to yield pure drinking water, the output has steadily decreased until again the film must be removed and the whole process repeated. A much larger filtering surface is necessary than if the filters could be worked at near their maximum speed for long periods.

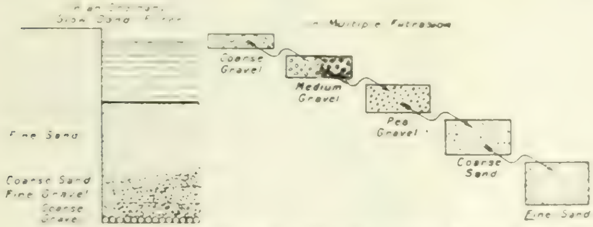


Fig. 1—Comparison Between Slow Sand and Multiple Filtration Plants.

Then, too, the labor of cleaning the filters and removing, washing and replacing the sand is considerable. This washing incurs, besides, a constant waste of water already filtered.

The school of engineers who support the film theory have developed a mechanical filter in which a film is created by the use of a coagulant and a high-speed filtration adopted.

The new school, however, now claims that the formation of a surface film, natural or artificial, is unnecessary and undesirable. These engineers retain the final slow sand filter, but clarify the water by passing it through successive layers of gravel and sand. This eliminates all solids held in suspension as well as spores of algae, while the nitrifying bacteria are allowed to pass and penetrate a considerable depth into the final filter.

A comparison of the relative working of ordinary slow sand filtration and multiple filtration is illustrated in Fig. 1. In the former after penetrating through the film represented by the thick black line in the left-hand illustration, the water first flows down through the finest material and then through successively coarser mediums. The reverse method is used in multiple filtration. The water first passes (right-hand drawing), through the coarsest materials and then in turn through finer and finer. Each bed removes some of the suspended matters until finally, before the water reaches the filter proper, they are all practically removed so that no clogging of the filter occurs. It is necessary, of course, to cleanse the materials in the preliminary beds, and fairly often to scrape the coarse and fine sand beds just before the final filter.

# Comparative Economics of Street Railways and Railless Electric Traction

Mr. Theodore Graham Gribble, M. Inst. C. E., in March 27, 1914, issue of the Surveyor and Municipal and County Engineer (Vol. 40), gives an instructive discussion of this subject. His conclusions, a brief summary of which follows, are all on the side of railless traction.

1. With a traffic density represented by a $2\frac{1}{2}$-minute service, equal to that of the largest British tramways, the cost of working is till in favor of railless traction, although only to the extent of about 7 per cent. The cost of construction is, however, about 44 per cent less.

2. The saving increases inversely with the traffic density, so that with a time interval of 30 seconds the cost of operation is about 36 per cent less, and that of construction about 70 per cent less. The frequently expressed opinion that owing to the supposed greater current consumption and the cost of tire maintenance the economy of the trolley bus ceased at a service frequency of about 10 seconds is quite unfounded. A large number of British tramways now laboring under the burden of an annual deficit would, if their services had been worked by a railless electric traction, now be showing a surplus.

The writer calls attention, however, to the wider interests at stake. The saving of money is important, but the serving of the public is more so. The taxpayers may spend or save money as they like. If they prefer the greater expense of a tramway because they regard it as a greater convenience, no one can gainsay them. The vital point is that the tramway cannot serve the public as comprehensively as the "trolley bus." To serve the city best, the farthest suburb should be reached, and greater frequency of service be supplied in the center of the city by means of overlapping services radiation to the suburbs. The cost of tramway construction sets a limit to suburban extension which is not set by railless electric traction. In order to comply with the fundamental principles of providing the greatest benefit to the greatest number, the preferences of the wealthier occupants of the city should not be allowed to outweigh the claims of the less wealth dwellers of the suburbs to obtain at least some adequate means of transportation.

# Ventilation of Woodhead Tunnel, Great Central Railway

By JAMES B. BALL, M. Inst. C. E.

Minutes of Proceedings of the Institution of Civil Engineers.

The Woodhead Tunnels of the Great Central Railway are situated in the main line between Manchester and Sheffield. They are 3 miles 13 yards in length and pierce the Pennine Chain.

Figure 1 shows the twin tunnels and the ground left between them. They are perfectly straight, lie almost due east and west, and were opened for traffic in 1845 and 1852, respectively. Five construction shafts, each about 8 ft. in diameter, were sunk on the center line between the two tunnels, Nos. 1 and 2 shafts at the western end being subsequently blocked by debris; the other three were not connected with the tops of the tunnels, but had only small side connections, the question of ventilation evidently not being considered of much importance. As the volume of traffic increased, the point of ventilation became urgent, and, since almost all traffic in the down-tunnel—going west on a falling gradient of 1 in 200—was taken through without opening the engine regulator, shafts Nos. 3, 4 and 5 were entirely closed to this tunnel and new throats were formed from the roof of the up-tunnel into the shafts. Some relief resulted, but conditions in the up-tunnel on the rising gradient of 1 in 200 against all traffic became gradually worse as traffic grew.

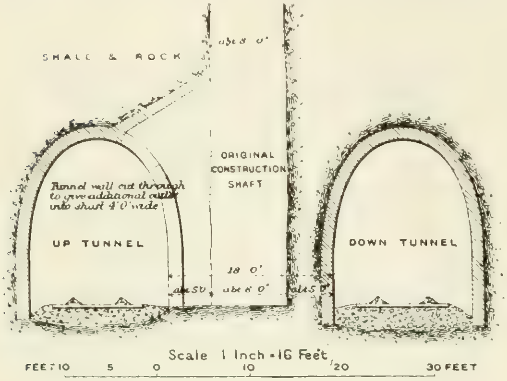


Fig. 1.

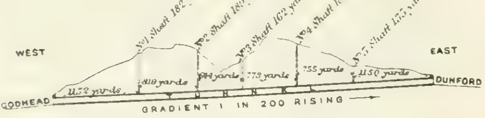


Fig. 2.

After a study of the problem under varying atmospheric conditions, and after obtaining by means of self-recording anemometers the velocities and directions of the air currents in each shaft, and taking into consideration the windage and the volume of traffic, the work was begun.

An attempt to effect the widening by means of a suspended steel scaffold had to be abandoned, and a platform of small girders upon a suitable foundation was devised in the small shaft. From this platform strong trestles of timber, ranging between 10 ft. and 4 ft. in height, were built up to the stripping edges, and as the work proceeded the trestling was lowered until the platform was reached. The platform was then lowered and the operations were repeated.

A small compressed-air plant and winding-engine were erected and "Meco" machine drills were used for drilling the shotholes. When a round of holes had been drilled, one-half only were charged at one time, and were fired electrically from the surface, low-tension fuses and detonators being employed, all of which were carefully tested to prevent misfiring.

After stripping and widening to depths which had to be settled on the spot in accordance with the various strata passed through, a 9-in. lining of brindle brick in cement was put in, supported on cast iron curbs provided with a flange on the front edge to collect water arising from condensation or weeping through the brick lining (Fig. 3). Where the ground was bad, the brick lining was increased to 14 in.; immediately above the curbs a solid ring of cement concrete was put in behind the brickwork to give additional support to the brick lining, holes being left at intervals for the free passage of the water at the back of the concrete. The space between the excavation and the back of the brick lining was hand-

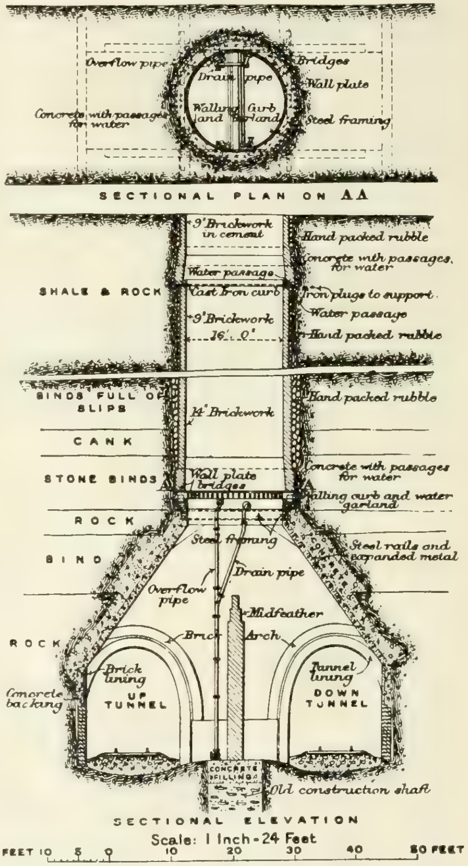


Fig. 3.

packed with stone to afford free passage of the water and to make the work perfectly solid.

To protect the traffic a special shield was fixed in each tunnel. These shields were formed of serviceable rails as ribs 5 ft. apart, 2 rails to each rib, bent to the curve of the old tunnel arch, and lined at the sides and under the soffit of the arches with 3-in. planks in two thicknesses laid to break joints. The shields projected 6 ft. from either end of the chamber into the tunnels and the voids between timber lining and soffits of the tunnel arches were puddled to prevent smoke from getting into the shaft. This was not, however, wholly prevented.

Because of the depth of the shaft and the treacherous nature of some of the strata, it was decided to make it 16 ft. clear in length. At each end between the two tunnels solid brick-in-cement walls 18 in. thick were carried up from a rock foundation about 4 ft. above rail level to the underside of the cast iron garland. As soon as these were completed the excavation was begun between these walls and over the tunnel arches, strong sets of timbering being fixed temporarily as the excavation proceeded. When this had been taken down to about 3 ft. above the extrados of the tunnel arches the center was left and excavation was confined to the north side of the up-tunnel and the south side of the down-tunnel and carried down behind the arches to their springing level. The sloping side-walls or roof of the chamber were then begun in Portland-cement concrete, strengthened by old rails interlaced with expanded metal, and carried up to the under side of the cast iron garland.

The shuttering was left up for several weeks, and meanwhile the remainder of the excavation over the tunnel arches and between the tunnels was done, leaving the tunnel arches bare and resting on the shields beneath. The cross-wall, or mid-feather, was then built between the end walls and carried well above the tops of the tunnel arches, to such a height that the area between the shaft bottom and the top of the mid-feather is slightly larger than the cross-sectional area of one of the tunnels. Both tunnel arches were then removed and the end walls completed, after which the up-tunnel shield was taken out and the shaft became open to the up-tunnel.

Hourly anemometer readings for 12 hours daily were taken during the week prior to removing the down-tunnel shield, and the upcast observed amounted to a maximum of 16,724,000 cu. ft. per hour and a minimum of 2,274,000 cu. ft., with an easterly wind blowing up the tunnel. With a westerly wind prevailing the maximum upcast observed was 14,953,000 cu. ft. per hour and the minimum 2,296,000 cu. ft. per hour; but with this wind the action of the shaft was somewhat intermittent, as four observations gave a maximum downcast of 9,855,600 cu. ft. per hour and a minimum of 1,408,000 cu. ft. per hour. Upon the removal of the down-tunnel shield, which threw the shaft open to the two tunnels, a marked improvement in the upcast effect was at once observed and the downcast action was entirely overcome; the steady efficiency of the shaft was much increased. Its work was recorded for more than a month, and the average daily work in upcasting for the whole period was 10,083,200 cu. ft. per hour. The effectiveness of shafts Nos. 1 and 3 was also much improved.

# Determination of Voids in Concrete

[illegible]

While engaged upon the construction of a large concrete reservoir, the author made some measurements with the object of arriving at a balance between the resulting volume of a batch of concrete and the volume of the separate constituents, and thus of determining the voids in the concrete itself.

The proportions of the concrete under consideration were 5, $2\frac{1}{2}$ and 1, which was the mixture used in the building of the reservoir walls. Set concrete was regarded as being made up in volume of five distinct components, as follows:

(1) Net volume of cement.
(2) Net volume of sand.
(3) Net volume of stone.
(4) Volume of water taken up by cement in setting.
(5) Microscopic voids, left for the most part by excess water drying out.

By the term "net volume" is meant volume of particles only, exclusive of voids. Of the above, (1), (2), (3) and (4) were determined directly while (5) was determined indirectly from the final density of the concrete, as explained below.

Voids in Cement.—The cement in the cask had a density of 87.2 lb. per cubic foot, while its specific gravity as determined in the laboratory was 3.12, equivalent to a density of 195 lb. per cubic foot. The voids were thus 55.2 per cent.

Voids in Sand.—These were found by measurement with water to be 34 per cent.

Voids in Stone.—These were similarly found to be 48 per cent, the stone being a granite broken to 2-in. gage.

Water Taken Up by Cement in Setting.—This was determined in the laboratory, and was found to be 18.55 per cent by weight of the weight of cement.

Working on these figures, together with the known densities of the sand and stone, Table I was compiled. In this table the figures in column B represent the quantities used in a batch, taking the cask of $4\frac{1}{3}$ cu ft. as the unit.

TABLE I.

| | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| | Item | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1 | [illegible] | 4.33 | 55.2 | 1.94 | | 195.0 | [illegible] |
| 2 | [illegible] | [illegible] | 34.0 | 7.15 | [illegible] | 152.0 | [illegible] |
| 3 | [illegible] | [illegible] | 48.0 | 11.26 | | 168.1 | [illegible] |
| | W[illegible] | [illegible] | | 1.08 | | | [illegible] |
| | M[illegible] | | | X | | | |
| | [illegible] | | | [illegible] | | | |
| | [illegible] | | | | | | [illegible] |

*Per cent by weight of cement.

The measured density of the concrete when thoroughly set was 146 lb. per cubic foot; it followed, therefore, that the value for "X" in the Table was 2.04 cu. ft.; bringing the total theoretical volume of a batch up to 23.47 cu. ft. As a batch in the work measured 23.22 cu. ft., this was a very fair agreement. The value of 2.04 cu. ft. for the voids in a batch of 23.47 cu. ft. corresponds with 8.7 per cent of voids.

In an independent investigation, the loss of weight by drying during the setting of very wet concrete was found to be 5.6 lb. per cubic foot. This would correspond with 9 per cent of voids, which is in very close agreement with the former result.

# Engineering Features of Lake Margaret Hydro-Electric Power Scheme

The Engineer.

The Lake Margaret hydro-electric power scheme has several interesting features. Lake Margaret is set high up on the West Coast Range of Tasmania, and lies in a roughly triangular valley formed by the ridge of Mt. Sedgwick on the south, the ridge comprising Mt. Geikie and Tyndal on the west, and a ridge connecting Mts. Geikie and Sedgwick on the east. The lake has a maximum width of 40 chains and a mean area of 300 acres. The surface of the water at spillway level is 2,143 ft. above sea-level. The approximate catchment area at present appropriated is 7 square miles, and the rainfall on the average about 114 in. per annum. This catchment area may be increased by suitable races, etc.

It was not necessary to construct an impounding dam in the ordinary sense of the word, for there was a natural dam at the mouth of the lake, and the actual procedure was to lower the water of the lake temporarily so that the draw-off pipes might be laid at the desired level. This was done by means of a channel cut to the requisite depth, partly through rock and partly through sand and conglomerate boulders for a total distance of 800 ft. The net depth of storage obtained in this manner was 16 ft., which was the difference in height between the spillway level and the top of the outlet pipes. As the total amount of storage which is at present required to carry the plant over a period of drought equal to the longest on record is represented by a depth of only 7 ft. of water, it is evident that there is a good surplus margin. It may be mentioned that with the present load on the power station the consumption of water is at the rate of 45 gal. per second, or 24,300,000 gal. per day. When the pipes were drawn down to the requisite level, outlet pipes and screens were laid in the trench and the latter was then closed by a concrete wall which was built up to spillway level. The pipes and screens were in the wall. A good portion of the work entailed in the cutting is now covered by the water.

The outlets from the lake consist of two 48-in. internal diameter cast-iron pipes set in the concrete wall. On the upstream side each pipe terminates in a screen compartment fitted with double screens of woven copper wire of ¾-in. mesh. Each screen can be raised separately for cleaning. Between the lake and the screens, flat sluice gates are provided to allow access to the screen chambers when the latter are closed. On the downstream side the pipes are each provided with a 48-in. diameter sluice valve, operated through worm gear by hand or by electric motor controlled from the power station switchboard. Only one of these outlet pipes is at present required to supply the station, a second being provided for extension; but the pipes are interconnected so that either can be used for the present service. Excepting the sluice valves, the whole of the metal work, including pipes, screens, sluice gates, etc., was made in workshops at Queenstown, Tasmania.

The pipe line from the lake to the power station consists of two distinct sections. The upper section, which is made of wood, is laid around the spur of a hill on a flat gradient, and really takes the place of the open channel common to so many hydro-electric installations. The wood pipe has many advantages, for it avoids debris, allows every foot of head to be utilized, and obviates loss of water by soakage and evaporation, as well as economizes water, since only such water as is required by the turbines from time to time is drawn from the storage. This section of pipe line is of wood stave construction. It has an internal diameter of 48 in. and the staves are 30 in number around the circumference. The wood is thick, seasoned Oregon pine, machined all over, with a V-grooved side joint and metal-tongue butt joint on the ends of the staves. The staves are held together by mild-steel bands ⅝ in., ¾ in. and ⅞ in. diameter, according to the pressure. The total length of the pipe is 7,250 ft.; total fall, 45 ft., and the sharpest curve 150 ft. radius. It is 48 in. in diameter, and is carried up the adjoining spur to a height 8 ft. above lake level. Local King Billy pine was used for this pipe.

The lower section of the pipe line or pressure column is laid down a very steep mountain side between the steel header and the power station. The total length of the line on the slope is 2,993 ft. and together with the head in the wood-stave pipe and the lake storage, a total static head of 1,100 ft. is provided. The pipeline is in duplicate and made of steel. It is in three sections of varying diameter—29¾ in. internal diameter at top, 26 in. in the center, and 22 in. at the bottom section. The thickness of plates used varies from 7 mm. at the top to 14 mm. at the bottom, and the pipes are solid welded throughout. The muff or stuffing box type of joint is used throughout the line, and there are solid welded flanged joints on the distributing pipes, branches, etc., outside the station. Each line is provided at the top, near the junction header, with a 29¾-in. sluice valve, hand-operated, and also electrically operated from the power station switchboard. A small air valve is placed at the head of each pipe. The two steel pipe lines outside the power station are joined together with a connecting casting which is also used as a thrust block for the end of the line, and in conjunction with valves, allows either pipe line to supply the turbines. Both pipe lines are solidly embedded

48-in. Wooden Stave Pipe Line of Lake Margaret Power Project.

in large blocks of concrete at all changes of gradient and direction, and each separate pipe is supported near the joint on a masonry pedestal.

In order to keep a continuous record of the water used, a Venturi meter is fixed in each of the distributing pipes. The three main central sluices and valves are 22 in. in diameter. They are operated by a hydraulic cylinder, working off the pressure column, which in turn is controlled by pilot valves and a small electric motor put into operation from the power station switchboard. These valves may also be operated by hand. A view of the wooden portion of the pipe line, with the construction track beside it, is shown in the illustration.

## Governmental Drainage Operations in New Zealand

The Engineer

The Rangitaiki Plains abut on the Bay of Plenty on the eastern side of the Province of Auckland, on the north coast of North Island, New Zealand. Here the Governmental Drainage operations are affecting an area of 87,000 acres. A few years ago the country was practically valueless. Within 5 years the Government engineers at a cost of a little over £61,000 ($300,000) have made it capable of becoming one of the most productive areas in the whole of New Zealand. The bulk of the land is now completely unwatered, and everywhere are to be seen active signs of farming. A low estimate of the rise in the value of the land, over and above the costs of drainage, is at least $5,000,000.

The soil is amazingly rich, and the climate excellent. Maize and all classes of crops grow with extraordinary vigor and the pasturage is so luxuriant that dairying can be carried out successfully on smaller areas than in any other part of New Zealand. It is anticipated that in the near future large sums will be contributed from the district to the revenues of the country. Moreover, the drainage operations will do more than bring about a direct increase in agricultural production. The lowering of the water-level over a great area of flat country, the turning of erratic rivers, and the control of floods makes possible the immediate extension of the East Coast Ry., and this extension will stimulate close settlement and encourage intensive farming in a manner undreampt of now.

Within the areas of the Rangitaiki Plains proper, and including lands outside as well as those inside the drainage area, there are in the neighborhood of 200,000 acres of level land, including some of the richest soil in the Dominion. Under quite primitive grass farming, it is stated that some of the land today is yielding over £10 ($50) an acre from butter alone. In the places where maize growing has been carried on, yields of over 100 bu. per acre have been obtained, and crop after crop has been harvested without manure.

Throughout 1916 three dredgers were busily engaged on the Rangitaiki swamp in completing the major works. During the summer months double shifts were worked, and this, though slightly increasing the cost per cubic yard of material removed, was much more than compensated for by the time saved in bringing the country under cultivation and making it productive. During the year a total of 268,760 cu. yd. of spoil were excavated at a total cost, including all charges, wages, supplies, repairs, etc.—but not, apparently, depreciation—of £3,901 10s. 6d. This works out at 3.48d. (7 ct.) per cubic yard, and is just over ¾d per cubic yard more than in the Hauraki Plains, northwest of this district. The increase is due partly to working double shifts and partly to dredging in difficult ground which necessitated the blasting and removal of a considerable amount of submerged timber and dealing with an exceptional quantity of fine sandy deposit which was difficult to handle with grab dredgers.

## Experiments on Earth Pressures

From a paper read by E. M. [illegible], M. Inst. C. E., before [illegible]

The paper begins with a short account of Rankine's theory of earth-pressure, and the principle and assumption on which it is founded. Descriptions of former investigations are given in some detail, namely, those of the late Sir George Darwin, and Messrs. Goodrich, Wilson, Bell and Meem. The author concludes that of their experiments to investigate the lateral pressure of earth, those in which model walls were used are of the greatest value, but points out that if models are of any size the experimental difficulties are almost insuperable.

The author's experiments, a number of which are described and illustrated in the paper, were made by loading a plunger with known weights and measuring the penetration when the plunger had come to rest after the application of each weight. The materials were enclosed in an open bucket, and their weights determined.

With those data the value of Φ, the angle of internal friction, can be obtained from Rankine's well known formula for the safe depth of foundations—

$$d = \frac{P}{W}\left(\frac{1 - \sin \Phi}{1 + \sin \Phi}\right)$$

where d denotes the peneration; P the pressure in pounds per square foot; and W the weight of the material in pounds per cubic foot.

If the formlua is true, and the pressure be plotted against the penetrations, the resulting curve is a straight line, and $\phi$ as calculated from the formula should equal the angle of repose.

With sand, garden earth, and cinders and ashes the resulting curves are straight lines, but it was found that the value of $\phi$ varied with the state of aggregation of the material, i. e., whether it was lightly poured into the bucket, shaken in, or well pounded in. When the material was deposited in the bucket as lightly as possible the angle of internal friction was the same as the angle of repose, but with more consolidation the angle was much greater.

From these materials the author concludes that Rankine's theory holds, provided the proper angle of internal friction be used and not the angle of repose. If, however, this angle be used it would be necessary to introduce a factor of safety into the formula for a wall designed without one would be theoretically just strong enough and no more. In Rankine's formula there is no factor of safety, and it is concluded that Rankine saw this, and used the angle of repose as covering the worst conditions that need possibly be provided for. The author's experiments show that, for the materials tested, work designed by Rankine's formlua, using the angle of respose, would have a factor of safety of 2½ to 4, and he considers that these are not unreasonable figures for such materials.

The experiments of clay give altogether different results, for instead of the penetration varying as the load, it varies as the square of the load and the penetration curves are parabolas. These results, which were altogether unexpected, are completely confirmed by larger experiments carried out by Messrs. Coode, Matthews, Fitzmaurice and Wilson and by Mr. McAlpine in New York.

The author is able to give no physical explanation as to why the penetration in clay should vary as the square of the load, but leaves it to the physicists. The law must be capable of some rational explanation, and, if true, it upsets all earth-pressure theories when they are applied to clay; for all accepted theories assume that the angle of internal friction is the same as the angle of repose, and that its value is independent of the pressure. It is suggested that the subject is worthy of further investigation, but that such could hardly be made by a private individual, for the work is tedious, each experiment taking from 24 to 48 hours. Moreover, if the investigation is to be properly carried out physical and chemical analyses of the clays will be required that could only be made in a well equipped physical laboratory.

In connection with the earth slides experienced at the Panama Canal it has been suggested that in clay and shale cuttings there is a critical depth beyond which the slides will not stand, and the author's experiments on clays clearly show that for these this must be the case. Where $\phi$ is independent of the pressure the depth of the cutting cannot affect the stability of the slope, but where the angle decreases with the pressure it is evident that eventually a depth will be reached beyond which its sides will not stand.

This decrease is clearly shown in one experiment on mud for which the angle for a pressure of 0.25 ton per square foot was 17° 15 ft., which decreased to 2° 10 ft. at a pressure of 1.25 ton per square foot, when it was little better than a liquid.

# Theatre des Champs Elysees a Notable Example of Reinforced Concrete Construction

Concrete and Constructional Engineering.

This building affords a good example of the application of reinforced concrete to the construction of a theater, this material being employed throughout for the weight-carrying members. The whole of the decorative effect is governed by the construction as regards main lines and features. Even in the elevations the constructional piers are allowed to form the main lines, and the enrichment is confined to the filling-in panels.

A good general idea of the framing may be gathered from the skeleton shown in Fig. 1. Great depth was required under the stage, which necessitated a very deep basement, while the ground floor was to be kept as near as possible to the pavement level. So there was water to be considered, as the basement floor is below the level of the neighboring River Seine. The lower floors were accordingly constructed like a great dish which forms the seating for the vertical divisions which are water-tight and which, being carried up to the ground floor level, act as stiffening to the dish. To support the considerable pressure under the stage and the electrical machinery, concrete pipes were driven at certain points while in other cases the load was distributed directly to the soil. The piles are connected by large reinforced beams spaced at intervals of about 6 ft. 9 in.; the slabs between are curved with the concave surface above in order to resist better the upward pressure of the soil.

The most interesting feature of the whole construction is that employed in connection with the auditorium. Here the loads are carried by what are practically two large reinforced concrete frames, each consisting of deep beams at the ground level, and above the ceiling of the auditorium with connecting columns. The beams at the lower level are deep, with open-web, having at intervals two flanges connected by stiffeners; these beams are in pairs with a curved connecting slab between at the soil level. The columns at the ends of the frames bear on these, four columns to the side of each frame, two occurring as piers in the walls and the other two formed as columns on the circumferential line at the back of the circle. All these are heavily reinforced, and the columns and piers are connected by large reinforced beams at the top which act as the bearing for two large arched reinforced beams, 95 ft. in length, in each frame. The upper part of the structure is suspended from these frames (see Fig. 1). It is a very ingenious and bold method of construction, which leaves the large auditorium space free and unobstructed and yet holds the structure rigid and distributes well the loads on the soil.

The columns in the vestibule are all constructional members of reinforced concrete arranged to form a very effective colonnade. The floors of the theater, foyers and corridors are all constructed of reinforced concrete, the spans in many cases exceeding 20 ft.; the beams are generally allowed to project below the slabs to form panels which remain as part of the decorative treatment. All the walls are constructed of the same material, these usually consisting of vertical columns and horizontal main beams, with the slab filling between the latter in many cases consisting of brickwork to which white marble lining is attached as a facing. The large auditorium is chiefly lighted by a 50-ft. circular shell which forms a feature in the ceiling decoration. This shell is composed of crystal filling in a framework of small bronze bars; some of the lamps edge the shell and indirectly light the auditorium, while strongly lighting the painted frieze which is an important factor in the decorative treatment.

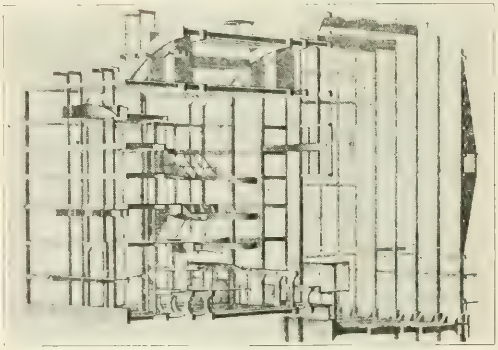


Fig. 1—Skeleton of Reinforced Concrete Work, Theatre des Champs Elysees.

But it is after all the straightforward manner in which the material has been employed, by making the constructional members part of the decorative scheme, which most satisfies the senses as giving an excellent example of what may be termed honest construction.

# The Manufacture of Oxygen and Its Use for Welding and Metal-Cutting

By J. M. CHRISTIE, Calcutta, India.

Proceedings, Institution of Mechanical Engineers, England

Until 1905 all the oxygen gas used in the United Kingdom was produced chemically. In that year a plant was installed in Birmingham whereby oxygen was manufactured mechanically through the liquefaction of air. The new method rapidly superseded the older, and large plants were erected in British engineering centers, and, more recently, in Calcutta, Bombay, Shanghai and other Eastern ports.

**Mechanical Production of Oxygen.**—In the production of oxygen mechanically, the result depends upon a certain amount of refrigeration, produced by the expansion of a gas which has been cooled, and intensified to the point of liquefaction. If liquid air is evaporated the nitrogen volatizes more quickly than the oxygen, and the remaining liquid becomes richer in oxygen.

Air is drawn through a tank of slaked lime to purify it, then is compressed by powerful pumps, dried, cooled, expanded, liquefied, and disassociated into nitrogen and oxygen. The nitrogen, after helping to cool further supplies of air to liquefaction, is returned to the atmosphere. Air enters the first stage of a compressor and is delivered through water-cooled coils before passing through three more stages, being cooled between each. When the compressor is first started, the final delivery pressure is 2,000 lb. per square inch, and the expansion pressure beyond the regulating valve 5 lb. per square inch, but after liquefaction the normal working pressure during the separation of the oxygen and nitrogen falls to about 700 lb. per square inch and the expansion pressure to 3 lb. per square inch. The air, at high pressure, is then delivered through bottles containing calcium chloride and thoroughly dried (to obviate the freezing of moisture and consequent obstruction of the separator coils, etc.), and enters the forecooler to be cooled in a refrigerating machine by means of ammonia or $CO_2$.

From a forecooler this high-pressure air, at much lower temperature, is passed through pipes in a separator, and being further cooled by ascending waste nitrogen and distilled oxygen, is liquefied. It then falls into a receiver, where the nitrogen, evaporating during its progress to the atmosphere, gives up its cold to the oncoming compressed air, and assists liquefaction. The liquid oxygen, during evaporation and on its way to the gas holder, also gives up its cold to the on-coming air. As liquefaction takes place, and the interchange of heat and cold continues, the normal process becomes automatic, and terminates with a final delivery pressure of about 700 lb. per square inch and an expansion pressure of 3 lb. per square inch.

The oxygen passes into a gas-holder, and is then compressed by pumps to 1,800 lb. per square inch into steel cylinders. The standard cylinders for welding work are of 100 cu. ft. and 200 cu. ft. capacity, but small cylinders of 40 and 20 cu. ft. capacity are employed for other purposes. All cylinders are subject to the rules of the Indian Government and of the Indian Railway Board. They are annealed every three years and tested annually to a hydraulic pressure of 1½ tons per square inch for 1,800 lb. working pressure. A permanent stretch of not more than 10 per cent is allowed.

**Oxy-Acetylene Welding.**—In 1899 the late Mr. Thomson Fletcher of Warrington showed that, after heating an iron plate to incandescence by means of an oxygen and coal gas blow-pipe flame, it was possible, by largely increasing the oxygen, to "fuse" holes in the plate. Later the same process was applied to the opening of tuyeres in blast-furnaces which had become blocked by the solidification of the metal. The operations paved the way to the present-day blow-pipes.

In oxy-acetylene welding on the high-pressure system the two gases enter the blow-pipe under pressure, oxygen from a standard cylinder and acetylene from a cylinder in which it is dissolved in a porous material soaked in acetone. This gives a portable system which is specially applicable to work on board ship, in boilers and confined spaces, and also for cutting away iron structures to get quick access to the seat of a fire.

In the low-pressure system oxygen is supplied under pressure and acetylene from a generator in which the carbide should not be decomposed too rapidly, to avoid great heat. For example, a "water on carbide" generator, with a capacity of 20 lb. of carbide, should be regulated so as to run 5 hours and generate without recharging about 90 ft. of acetylene.

The purification of acetylene is highly important. It is first washed by bubbling through water, and then passed through a filter of felt to remove traces of lime dust which, passing through the blow-pipe, would injure the weld.

In practice the best welding results are obtained with 1½ volumes of oxygen to 1 volume of acetylene. The flame has in its center a small white cone, at the apex of which the temperature is about 6,000° F., and consists almost entirely of CO, which is being converted, at its extremity, into $CO_2$.

Autogenous welds can be made without injurious effect upon the metal. Bars of Staffordshire iron welded together by this system gave tests over 29 tons per square inch at the joint, while welded plates of iron and steel varying in thickness from 20 gauge upwards, have proved stronger at the joints than in the body of the plate.

The speed at which work can be welded varies with its nature. In the following table is given the speed per hour on iron plates:

| | Inches | Inches | Inches | Inches |
|---|---|---|---|---|
| Thickness of plate | [illegible] | [illegible] | [illegible] | [illegible] |
| Feet run per hour | [illegible] | [illegible] | [illegible] | 4 |

In welding cast-iron, especially thin sections, it is necessary to pre-heat the castings slowly to a dull red, to weld while in this condition, and then allow to cool slowly. In this way shrinkage strains will be equalized and cracks avoided. Preliminary heating and subsequent slow cooling in a muffle are most important, especially in light, intricate castings, such as motor-car cylinders. Before the advent of this process, cracked motor-car cylinders were almost invariably scrapped. Now, complicated defects may be repaired, but delicate work demands considerable experience. The process is particularly applicable for light machine castings. Malleable-iron and cast steel may be welded in the same manner as cast-iron.

**Metal-Cutting.**—Oxygen is regularly used for cutting wrought iron and steel structures. A jet of oxygen directed upon a previously heated spot of metal ignites it, and the metal acting as its own fuel burns pidly in the form of iron oxide, which, formed v temperature, lacks fluidity.

4 a new cutting blow-pipe was invented. It consisted of an ordinary blow-pipe, with an additional passage through which an independent and separately controlled stream of oxygen was supplied at the will of the operator. The expedient of maintaining an independent heating jet in operation whilst the cutter is traveling renders the cutting continuous.

The following examples of good average cutting are from experiments with a hand oxygen cutter which was only altered as required for the gas-pressure corresponding to the thickness of the plates:

| Thickness of plate. Mild steel. Inch. | Foot-run of metal cut per hour. Feet. | Total quantity of oxygen consumed per hour. Cubic feet. | Pressure of oxygen supplied to cutter. Atmosphere. |
|---|---|---|---|
| ½ | 60 | 60 | 2 |
| 1 | 40 | 90 | 2.5 |
| 1½ | 30 | 105 | 3 |
| 2 | 25 | 120 | 3.5 |

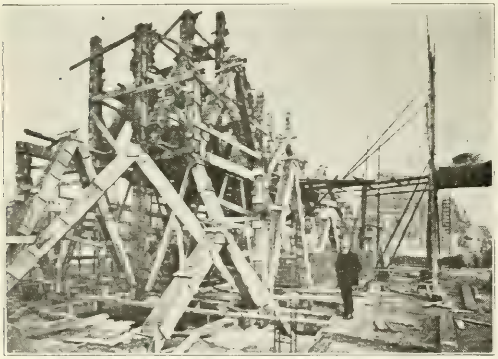
# A Reinforced Concrete Panorama for Zoological Gardens

By ALBERT LAKEMAN.

Concrete and Constructional Engineering.

The primary object of this panorama is to show the animals so that they appear in a state as nearly as possible resembling the natural. The plan is that of a quadrant, with a radius of 288 ft., so that the scheme covers an area of about 260,000 sq. ft.

The panorama is divided by three terraces for visitors. These are at varying levels, with a wide flight of steps at either end. At the center of the quadrant is a tea house adjoining the lower terrace; beyond this terrace, at successively higher levels, lie a duck pond and four large enclosures for deer. A reinforced concrete wall separates the latter from the terrace, and beyond is a large dry ditch to prevent the bears from jumping out of the enclosures arranged for them between the middle and upper terraces. There are six large bear enclosures, each containing a swimming tank, while the enclosure is undulating and constructed to resemble natural rocky ground as far as possible. On the circular edge of the panorama four goat-hills rise to a height of 70 ft. from the ground level.



Bracing for 70-Ft. Concrete "Hill."

These hills are one of the most striking features of the scheme. The illustration (Fig. 1) shows the difficulty of bracing for such irregular contour. One of the finished hills is seen in the distance, although its full height is somewhat lost, since the view is taken from the middle terrace. The construction of these goat-hills required a great deal of careful consideration because of their irregularity and the necessity that they be very rigid because of their height. The lower part of the construction consists of several rows of columns about 17 ft. above the ground level; the actual hill does not begin until this level is reached. The spaces below are variously used; in one instance by a large water tank which supplies the bear ponds, in another by a hall which is to be used for lectures. Two rows of columns only are used here, and large reinforced concrete trusses with a span of 42 ft. These slabs were formed by ramming the concrete between two layers of wire netting spaced at the proper distance apart; the ramming of the concrete caused the netting to bulge and produce an irregular surface; in addition the fine stuff protruded through the holes in the netting. The outer surface was treated with a stiff broom which caused the projecting stuff to spread and cover the netting entirely, simultaneously furnishing a suitable surface for the goats to climb. A ladder inside the hill allows the keeper to get to the top with food, which, being passed through a feeding hole, induces the goats to climb up into view of the visitors.

The bear enclosures are separated from one another by high division walls formed of concrete; a rustic effect is obtained by the use of wire netting which has allowed the concrete to bulge. At the same time projections which would allow the bears to climb up the walls and escape have been carefully avoided.

The water tanks in these enclosures are generally suspended from the columns and slabbing and are very irregular. Without particular pains in construction these tanks were found to be perfectly watertight. It will be understood that there was difficulty in tamping the concrete when portions of the supporting centering were composed of wire netting only. The largest tank, 40 ft. x 17 ft., with a 6-ft. depth of water, is used by the polar bears, whose under-water antics may be seen through a series of observation windows at the deep end.

## The Painting of Iron and Steel

The Railway Engineer, June, 1916.

A remarkable discovery respecting the painting of iron and steel surfaces has recently been announced from the Continent, and is fully worth the careful consideration of engineers. It is to the effect that single coat of paint has been proved to resist the rusting of the metal more than either two, three or four coats. This is so distinctly contrary to accepted ideas on the subject that it seems to be almost fallacious; yet when we come minutely to examine all the details there certainly seems to be some fundamental reason for it, and, like many other new suggestions, it contains a good deal of truth.

The experimenters cleaned a number of iron plates and gave them one, two, three and four coats respectively. When the paint was thoroughly hard, dry and seasoned the plates were exposed for twelve hours to a steaming process. Then the paint coat dissolved off and the metal inspected. That which received a single coat was found to be still bright and uncorroded, while in the case where four coats had been applied a layer of rust was evident upon it, and the other two examples displayed varying proportions of oxide, which was greater where three coats had been applied.

# Bicable Ropeway, Half Mile Long, Passes Under Six Bridges and Makes Four Bends

[illegible]

One of the most complicated lines of ropeway in existence is carrying sugar cane in Madeira. So great were the difficulties presented that the well known German firm, Pohlig of Cologne, declined to tender for its construction, and the English company, Bullivant's Aerial Ropeways, Ltd., received the order.

The line is of the bicable type and starts at a wharf at sea-level and carries the sugar cane to a factory ½ mile inland. That is may offer the least possible obstruction in passing through the town, it is laid along the bed of a river for its entire length until it comes opposite the factory, where it turns up a tributary stream. In the short ½ mile of its length it passes under six bridges and makes four bends. In winter the river becomes a raging torrent confined between high stone walls. It was therefore inadvisable to place any of the supporting structure in its bed, so all trestles and angle-stations had to be cantilevered out from the walls or supported on girders fixed in them and spanning the river. Some of the bridges allowed a clear head-room from the river bed to the arch of not more than 10 ft. Yet it was necessary to avoid the bridge while clearing the highest level. Under even the lowest bridge an angle-station had to be provided. At the factory end the ropeway had to be bent almost through a right angle and led up a culvert through which the tributary stream flows into the factory building. It was as if the ropeway had to be erected within a sloping, winding tunnel, the cross-section of which varied irregularly from point to point, and down which a torrent sometimes roared. On portions of the line the gradient is about 1 in 9; the required capacity was 15 tons per hour in individual net loads of about 6 cwt. each, or about 50 crates each way per hour.

Starting at the wharf, or loading end, the line begins with a straight and fairly level stretch of about 400 ft., arranged in two spans. The low bridges close together and a bend in the river are then traversed by bending the line through an angle of 33° and by fixing the angle station close to the left bank on girders running between the retaining walls (Fig. 1). On the next stretch (400 ft.) the line rises at the rate of 1 in 16 to a slight bend (7½°) in the river, necessitating a second angle station. The third stretch measures about 1,550 ft. and is made in three spans, each of which passes under a bridge. The average rise in this portion is 1 in 25. At its end another bend in the river necessitates an angle station (Fig. 2) turning the line through 31°. Next follows a stretch of 660 ft. in one span during which the line rises at the rate of 1:20. Beyond the next bridge an angle station turns the line through 78°. The line thereafter leaves the river bed and passing up the culvert comes to the terminal at the factory.

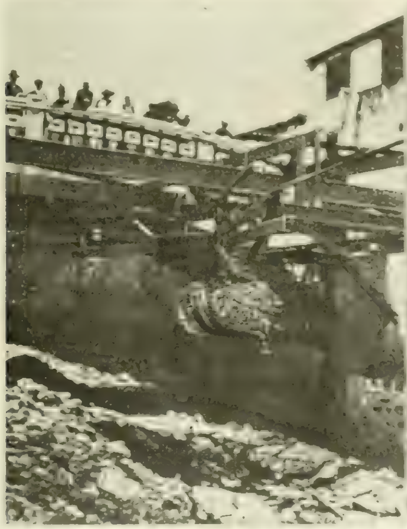


Fig. 1—First Angle Station.

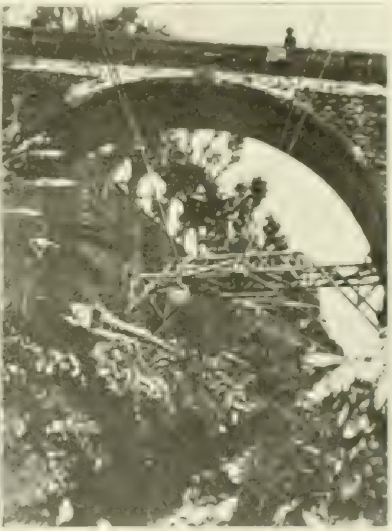


Fig. 2—Fourth Angle Station.

## The Purification of Water in Military Campaigns

The wisdom of all ages, concentrated in this question of purifying water for use in a military campaign, has now (says Captain J. C. McWalter, Mediterranean Expeditionary Force, writing in the Journal of State Medicine for February, 1917), reduced itself to adding a few grains of common chloride of lime to each 100 gal.—to be meticulously exact, 30 grains to 100 gal. of water. This minute proportion effectively kills off organisms of the coli group and renders the water perfectly potable—that is, if it was a fairly sound water before the chlorinating process.

The degree of strength of the chloride of lime is a constant source of uncertainty. It is supposed to contain about 33 per cent of available chlorine when fresh, but in tropical countries, where the supply is probably 6 to 9 months old, it has been found that the proportion varies from 8 to 24 per cent. It is now sent out in well-corked glass bottles

# Applied Geology in Municipal Engineering

By HERBERT LAPWORTH.

The Surveyor and Municipal and County Engineer.

The success of underground water supplies, the cost of works, of sewerage, of all deep excavations or foundations, is largely influenced by the nature of the geological materials met with in the trenches. The nature of the ground encountered during construction is perennially a matter of dispute between contractors and municipal authority. Invariably the cause has been misunderstanding of the geology of the excavations, and the result invariably costly. Intending contractors are often misled by trial borings; they are often compelled, under the contract, to a type of construction unsuited to the ground unexpectedly encountered; heavy expenses have been incurred by locating works in bad ground. All these troubles may be minimized or avoided with practical geological knowledge.

Engineering text-books take account of but two sorts of ground, "good" and "bad." They ignore the many types of underground material, the principles of the occurrence of underground water, and the difficulties of construction under different geological conditions.

Between the engineering text-book which sees only "rock" or "muck" and the geological treatise which contains much redundant matter from the engineer's standpoint, lies the geology which every engineer should know: the principles of stratification, the formation of rocks and deposits, and the structures occurring in them as the result of formation, change, weathering or earth movements. He should be able to recognize and describe all the common solid rocks, and unconsolidated deposits. He should understand a geological map as he does a working drawing, and be able to plot approximate geological sections from it, as well as accurate geological records from borings, trial holes, trenches and tunnels. A training in petrology is desirable for the road engineer, though proficiency requires more time than the professional engineer can afford.

Of equal importance is hydro-geology, which includes the principles of the occurrence of underground water in different geological deposits, the laws of flow through porous and permeable materials, and underground water levels and their fluctuations. To be sure, the extreme complexity of underground conditions shows that often the quantitative results of calculations have little application to practice. Nevertheless, such calculations help one to anticipate the complications to be met, and to deal more rationally with the underground water problem. A few selected instances upon which practical geology has a direct bearing are given:

(1) Investigation to determine the dimensions of the permanent work and probable cost and the ground water levels, to make it possible to judge whether a change of location is desirable, and to put in a fairer price.

(2) In questions of water supply, particularly from underground sources, where the selection of a site requires intimate acquaintance with the local geology, both as to rocks and superficial deposits. These cases, however, are often left to the consulting engineer.

(3) In the building of sewer and pipe lines, where unconsolidated deposits of recent geological origin often occur, lines have to be built in water-bearing rocks, or the opening of a deep trench in porous material drains surrounding territory, and lowers the water level of the vicinity. This latter may give rise to damage suits or compel the use of heavy pumping during construction. Hydro-geology will show the seasonal fluctuations in the saturation level, and aid in the treatment.

(4) In ground of soft clay, mud, silt, running sand or peat, special precautions must be taken in timbering, strengthening the permanent work, draining and fortifying the foundations below formation level, so as to enable the ground to support the overlying weight. Pipes must often be run through ground which has subsided because of coal mining or brine pumping. Sometimes the unsettled regions may be avoided; again, the question of purchase of underground minerals may arise. The choice of sites for sewage, irrigation, farms, and for cemeteries, the selection of routes for roads, all call for the application of geological and hydro-geological principles.

The engineer armed with a sound knowledge of geology will be more effectually prepared, whatever underground situation he may encounter. It is a subject which the well-informed engineer can not afford to neglect.

# Working Costs for Motor Sweeping at Hackney, England

The Surveyor and Municipal and County Engineer.

Mr. Norman Scorgie, M. Inst. C. E., borough engineer of Hackney, has prepared the following report on the working of the Laffy road-sweeping machine owned by the borough council during the year 1916-17:

| | |
|---|---|
| Number of days worked | 255 |
| Mileage recorded | 8,925 |
| Average per day | 35 |
| Length of roadway swept | 1,300 miles |
| Average per day | 5.1 miles |
| Petrol used | 1,038 gallons |
| Average per day | 4.07 gallons |
| Distance per gallon | 8.6 miles |
| Lubricating oil used | 50 gallons |
| Distance per gallon | 178 miles |
| Axle grease used | 140 lbs. |
| Distance per 1 lb. | 64 miles |
| Number of broom refills | 33 |
| Average life per broom | 7.7 days |
| Average wearing distance per broom | 270 miles |

INITIAL COST.

| | £. | s. | d. |
|---|---|---|---|
| Machine | 638 | 0 | 0 |
| Hood | 12 | 10 | 0 |
| Speedometer | 5 | 5 | 0 |
| Spare broom spindles (6) | 15 | 0 | 0 |
| | 670 | 15 | 0 |

WORKING COSTS FOR THE YEAR.
Life of the machine assumed as eight years.

| | £. | s. | d. |
|---|---|---|---|
| Depreciation, 12½ per cent | 83 | 16 | 11 |
| Depreciation on sundry additional plant, levers, lifting jacks, etc., 12½ per cent | 2 | 3 | 10 |
| Repairs and renewals (including a new tire) | 26 | 1 | 5 |
| Insurance | 10 | 4 | 0 |
| Wages paid to driver | 123 | 18 | 5 |
| Petrol (1,038 gal., 2s 2d and 2s 3d per gallon) | 116 | 7 | 2 |
| Lubricating oil (50 gal., 3s 4d to 3s 10d per gal.) | 9 | 0 | 8 |
| Broom refills (33 at £2 8s) | 79 | 4 | 0 |
| Axle grease (140 lbs.) | 3 | 2 | 0 |
| | 453 | 18 | 5 |

Equal to 6s 11.8d per mile of road swept.

Taking the work actually done by horse machines during the preceding year (1915-16), including the washing down in front of these machines, and calculating its cost at the prices which were in force during the year 1916-17, the total cost would have been £1,474. The cost of the work actually done by horse machines during the year 1916-17 was £890; the cost of the work of the motor machine, as stated above, has been £454; so that the total cost has been £1,344.

There has been a saving of £130, as compared with the previous year's work, when horse-drawn brooms were used exclusively. During 1916-17 prices were 15 per cent above those of 1915-16, and they are still increasing, so that the saving during the present on this one machine should be about £200.

## Cold Weather Concreting

As a result of experience gained over a number of years of winter concrete building in Canada, John Hammersley-Heenan, Assoc. M. Inst. C. E., offers the following suggestion:

The freezing of concrete will not damage it if it has first had a chance to set under favorable conditions for about 2 days. The effect of freezing is simply to delay the process of hardening, which will proceed under favorable conditions and eventually attain its full strength. If concrete freezes before it begins to set, it will not be injured if precautions are taken to prevent it from freezing again after it thaws until sufficiently hardened to withstand the effects of subsequent freezings. It is alternate freezing and thawing that does the damage.

To meet these conditions, when carrying out concrete work in winter, devise means of mixing the concrete with materials freed of frost, placing it in the forms before it has begun to freeze, and then protecting it and keeping it warm for about two days. After that it may be allowed to freeze.

In the case of a large mass of concrete, it is unnecessary to apply external heat, as the big body of concrete will generate sufficient heat in the process of hardening to enable the mass to set; it is necessary only to protect the outside of the concrete so as to keep the heat in. This can best be done by covering the concrete with clean straw.

For light sections of concrete such as reinforced concrete, poured at a temperature not below 22° F., some engineers allow salt to be used in proportion not exceeding 10 per cent. The author prefers not to use it except in marine work when the concrete is mixed with sea-water and the salt admitted in that form. Instead of using salt, good results are obtained for temperatures not below 22° F. by heating the water with a steam hose taken from the mixer-boiler, and when necessary placing a few coke or wood fires on the heaps of sand and crushed stone, the usual precautions being taken to protect the concrete when in the forms.

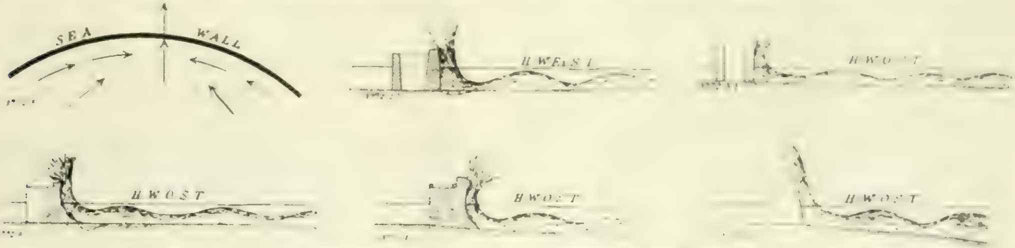
For lower temperatures greater precautions must be taken to heat the ingredients by means of steam coils or radiators. The concrete being mixed and the part of the work to be done decided upon, the floor immediately below should be partitioned off with tarpaulins and coke stoves arranged under the floor slab, one stove to every 800 sq. ft. of floor space. All loose dirt and snow must be removed from the forms with brooms, and a steam hose applied to remove all ice and frost, the steam playing continuously over the forms to warm them. The concrete should be poured quickly and continuously, and as each section is finished a tarpaulin may be drawn over it and supported on wooden strips about 6 in. above the surface of the concrete. Generally this will be sufficient, but in very cold weather it is wise to erect a sort of tent in which extra stoves may be placed.

If adequate fires are kept burning for two days, the concrete may afterward be allowed to freeze without fear. The work must be examined from time to time until found to be sufficiently hard. In summer the author has sometimes allowed the supports from the under side of the slabs to be removed in 4 days, but in winter often 4 weeks have been found not too long.

## Experiments with Breakwater Models to Determine Wave Action

In an article dealing with wave action on harbor breakwaters and piers, E. R. Matthers, Associate Member Institution Civil Engineers, gives results of his own experiments with breakwaters of various profiles:

**Wave Effect on Curved Wall.**—The apparatus used was simple: shallow enameled trays in which wave action was easily produced, and a breakwater made to scale in plasticene. One point of considerable interest was demonstrated, the folly of building seawalls curved in plan (concave curve) as shown in Fig. 1. As a result of this the wave strikes the seawall and runs along it, as shown by the arrows, and when the two portions of the wave meet the sea shoots upward and falls, usually at the back of the structure, sometimes doing considerable damage. The shape of the wall itself is of little help in a case of this kind. Even with a stepped-face wall the same thing occurred, but with slightly less serious effect.



Top Row: Fig. 1—Plan of Wall With Concave Curve. Fig. 2— Wave Stroke on Vertical Wall. Fig. 3—Vertical Wall With Projecting Cornice. Bottom Row: Fig. 4—Wave Stroke on Curved Forced Wall. Fig. 5—Wave Stroke on Curved Wall After Profile Was Amended. Fig. 6—Sloping Face Wall.

**Wave Stroke on Vertical Wall.**—The first type of wall experimented on was the "vertical wall." It was found that, when a wave struck this, if there was no provision for throwing back the wave, the latter shot upward to a considerable height and, if uninfluenced by the wind, about half of the wave fell at the back of the wall, causing much scour (Fig. 2). The dotted lines indicated where scour is produced.

**Vertical Wall with Heavy Projecting Cornice.**—Figure 3 shows the result of the wave stroke upon this vertical wall when a projecting cornice has been added. No portion of the wave went over the wall, but the whole of it fell back at the base, causing, in actual practice, considerable scour.

**Curved-Face Wall.**—Figure 4 shows clearly how this profile assists the wave in leaping over the wall. It is an outline not to be recommended.

**Curved-Face Wall with Projecting Cornice.**—Figure 5 shows how much better a wave is thrown back by the addition of a heavy projecting cornice.

**Battered-Face Wall.**—A sloping face wall, without any provision for throwing back the wave, is almost as bad as a curved-face wall, as the batter encourages the wave to ascend instead of retarding its progress, as in the case of a stepped-face wall. Experiments demonstrated that a wave will leap over a wall of this contour.

## Camp Sanitation

In a series of articles on Camp Sanitation in Vol. 46 of the Surveyor and Municipal and County Engineer, G. Bertram Hartfree gives some useful points on various phases of the subject.

In the paper on "Ablutions" he says: In the absence of anything more suitable, marquees may be erected and metal baths provided in canvas cubicles. Care is required in respect to the disposal of the foul water. By excavation in the earth and lining with a large wagon tarpaulin, a very useful bath can be provided. The water supply may be obtained by damming the stream and diverting the required water, or perhaps from a tap supplied from public mains. A waste channel must be secured leading from the lower end of the bath to the waste water trenches. The difficulty of clothes drying may be overcome by the familiar "devils" or braziers used by watchmen. These should be fed by charcoal, which is easily made in the following way: Dig a pit 2 to 3 ft. in depth and 4 to 5 ft. in diameter. Make in the pit a fire and feed continually, preferably with hard wood, so as to insure that as the hot embers sink to the bottom, the pit remains full of fuel. When the embers reach to the top of the pit, sufficient fuel should be added to reach a height of 18 in. above ground level, and the excavated earth covered over the burning mass. A fine, loamy soil gives the best results, as hard earths do not provide an airtight cover. At the end of 24 hours a pit full of charcoal will be obtained. In the absence of clothes-horses, copper or galvanized wire stretched on posts makes a useful substitute.

In the article on "Water" the author makes the following suggestions:

Canvas troughs are supported by wooden pegs kept taut by ropes; the more modern form is supplied with folding brackets which permit of quicker erection. The brackets consist of a metal base to which wooden or metal uprights are attached by hinge or socket. When canvas troughs abut longitudinally, it may be necessary to take the service pipe under those troughs nearest the main, and care must be taken that the brackets do not rest upon the pipe but that the pipe, while passing under the canvas, rests on the base of the bracket; otherwise the pipe runs the risk of fracture.

Should canvas be unobtainable, either trenches must be dug and lined with clay, or shallow metal tanks provided; or, time permitting, wooden troughs may be constructed. In erecting wood troughs all abutting boards should be planed true. Sounder joints are made by tonguing and grooving or by rebating edges and inserting large rushes which swell and close all cracks. Glue should not be used, but paint is excellent if applied before the joint is made, and grease also may be used if the excess is carefully wiped away. Hot pitch is efficacious if applied after the joint is made.

Should the ground be soft, a paving of rammed pitchings is necessary for the horses to stand on.

When supplies are taken elsewhere than from a water main, the following order must be observed, starting at the highest part of the stream: men's drinking water, horses' drinking water, washing, with camp drainage, if it reaches the stream, as far down as possible.

In rural camps it is desirable to mark every class of water by distinguishing flags. White is generally used to denote men's drinking water, and blue for horses. Red beside a running stream denotes an ablution station.

When treatment is necessary, and medical advice cannot be obtained, the following may be useful:

(1) To clear muddy water add 6 gr. alum per gallon some hours before use;

(2) To help remove organic matter add leaves that have been used to make tea; or

(3) Use permanganate of potash. If the familiar pink reaction does not appear, let the water stand and treat from time to time until a permanent tinge is secured.

Emergency filters can be constructed out of barrels, tins or anything at hand which will hold water. Barrels are especially useful, and for drawing supplies from lakes a large barrel containing a small barrel can be arranged so that clear water may be dipped out of the latter after its filtration through the media contained in the former. Charcoal, gravel and coarse sand are suitable for filtration.

## Ant-Hills and Railway Construction in Africa

The Railway Engineer.

In the course of a valuable paper on the Katanga District of the Belgian Congo read by Mr. E. A. Browning before the South African Society of Civil Engineers the obstructions and trouble caused by ant-hills to railway construction in Africa were described as follows:

In connection with the earthwork, a feature which begins to develop north of the Zambesi and continues as far as the railway has yet advanced, is the enormous ant-hills encountered. Ordinarily, it would appear ridiculous to speak of making a railway cutting through an ant-hill, but in the Katanga this is literally what one is obliged to do. The ant-hills are generally cone-shaped, and it is by no means uncommon to find them 20 ft. high and 60 ft. diameter at the bottom. The largest which the author has measured was 37 ft. high and 82 ft. in diameter at the base. To make a cutting through an ant-hill and remove 300 tons of earth in so doing is quite an ordinary proceeding. In removing one ant-hill, over 1,200 tons of earth had to be excavated. Upon the site of Elizabethville Railway Station, which has a length of about ½ mile and a width of ¼ mile, there were no fewer than 76 of these ant-hills, which cost over £3,000 to remove and level out. The sides of the cuttings through these ant-hills are found to stand very well with ½:1 slope.

The ant-hills are often found to be a source of trouble because of their uncertain state of solidity. Generally, if the ant-hill be entirely removed, or if the cutting be brought down to ground level, it is found that "slacks" are produced within the limits of the anti-hill, especially near its center; but if, as in a bank, the top only be removed or a slice taken out of its side, the anti-hill remains solid, and the made ground on either side of it sinks and so causes slack.

In excavating a cutting through one of these mounds one frequently chances upon a chamber which serves some purpose in the domestic economy of the ants.

This chamber is, perhaps, three or four feet in diameter, and is filled with a drab-colored structure of wood pulp, cemented firmly and built up something like a honey-comb. In this chamber the queen ant is sometimes found, an ugly, grub-like creature, without legs or wings, and reputed to be capable of depositing 14,000,000 eggs. These chambers evidently serve as breeding places or as ventilating shafts. In any event the exposure of them seems to be a source of annoyance to the occupants, as they very quickly set about the repair of their house. Their usual method is to seal the exposed surface by plastering it over with soil worked up into a clayey state, so that within a day or two an excrescence like a carbuncle appears to grow from the surface. When this happens under the permanent way it is a great nuisance, because thereby the rails are raised at that point and often distorted from their proper alignment. The author has known rails to be lifted about 1 ft. from their proper level in a few days, and it has taken months to defeat the operations of these indefatigable creatures.

# The Alexandra and Hughes' Docks, Bombay, India

Indian and Eastern Engineer

The new Alexandra dock, which is really a large basin, has a water area of 49½ acres and a depth of 37½ ft. at mean high water, and is capable of accommodating steamers of the largest size which visit the East.

The entrance lock, which is 750 ft. long between the sills and 100 ft. wide, has a depth of water of 23 ft. over the inner sill at lowest ordinary spring tides and 37 ft. 3 in. at high water spring tides. Steamers, not more than 750 ft. long drawing 22 ft. of water, can be locked through to the dock at any state of the tide Vessels of greater length than 750 ft. have to wait till nearly high water when both gates are opened.

Inside the dock there are 17 berths, 500 ft. to 520 ft. in length. These berths are equipped with 35 cwt. hydraulic cranes, and train shed accommodations carrying from 3-storied sheds, 400 ft. long by 128 ft. wide, to single-storied sheds 400 ft. long by 107 ft. wide. Railroad sidings run between the quay and the sheds; also behind the sheds.

It is intended to use the east side of the mole, which runs for 1,500 ft. south of the entrance lock, as a mail steamer berth, where all passengers and mails will be landed without the intervention of tenders. The mail trains will start from this point with up-country passengers and mails shortly after the arrival of the mail steamers. The west side of the mole is intended as a berth for troop ships.

The Hughes Dry Dock, which is 1,000 ft. long with an entrance of 100 ft. in width, is situated at the south end of the Alexandra dock and parallel with the entrance lock. The dimensions of this dry dock are sufficient to accommodate the largest English battleship. It has three central caisson grooves for dividing the lock into two, and is provided with three sets of keel blocks, so that while it is capable, when used as one dock, of accommodating the largest steamer afloat, it can be made available for four vessels up to 460 ft. in length to be dry-docked at the same time, two side by side in the inner half, and two in the outer half. The whole dock area is provided with a system of railway sidings, some 26 miles in length, where cars may be loaded and unloaded.

Hydraulic power is used for operating the cranes, dock gate machinery, train shed lifts, etc.

The total estimated cost of the new docks, including the Communicating Passage between the Alexandra and the Victoria docks, was roughly $20,000,000.

# The Employment of Women in English Munition Factories

In an article in The Journal of the Institution of Mechanical Engineers, dealing generally with the subject of this title, Miss O. E. Monkhouse gives some of the results of her own experience in the employment of women in munition factories.

The successful employer of women faces squarely the fact that the psychology of the woman worker is different from that of the man. He next fixes on work suitable to his new type of employe and then determines the quickest and easiest way to train her for it. He next appoints an experienced woman to engage and look after the women.—Here, parenthetically, the author says that there is no doubt that in general a woman is a better judge of a woman than is a man. A case recently came to her notice where one side of the labor was chosen by a woman and the other by a man. There was great complaint of the inefficiency of the latter, but none of the former. Investigation disclosed the fact that the women "turned down" by the woman supervisor were generally engaged by the man.—Finally, the employer selects as a technical overseer a foreman who is sympathetic with the new venture.

Skilled men must do the technical training and must use all their skill to train the inexperienced women. They have to sectionalize the work, adapt machinery, simplify operations so as to make it possible to employ women. In their hands lies largely the power to retard all progress by women on skilled work, because at the outset hardly a woman is in a position to know when obstacles are being placed in her path. She has, perforce, to rely upon men's generosity and her position in engineering shops today shows that she has not relied in vain.

On the other hand every man is not a teacher, and every teacher of men does not necessarily make a suitable teacher of women. The unequal success of women in different shops is due partly to this cause as well as to antagonism on the part of the men.

The unskilled woman in engineering works has a great deal to face. Her difficulties may briefly be summarized as follows:

(1) She is usually unaccustomed to factory life and discipline.

(2) Her works manager and foreman may be unaccustomed to managing women workers.

(3) The shop conditions are probably planned with a view to the employment of men.

(4) She has hitherto been unaccustomed to machinery.

(5) There is difficulty in maintaining discipline in a mixed shop, and in entirely female shops staffed by women of no previous factory experience.

(6) The long hours.

(7) The question of physical strength.

Most of these difficulties have been overcome by careful selection of suitable work, a wise choice of labor, proper shop conditions and organization, conforming to definite welfare standards, installing or adapting plants suitable to women's use, supplying proper training facilities, subdividing skilled work and adapting the hours of employment in accordance with the class of work done.

That women have done as well as they have is attributable largely to three causes: (1) They have been definitely taught, whereas the apprentices had to pick up their trade. (2) They have mostly been intensively taught everything in the shop itself under production conditions rather than in the school. (3) Conditions of the time have spurred everybody on to greater effort from patriotic motives.

Just a few large firms have done the ideal thing and set up their own training schools, from which they have a continuous flow of semi-trained labor always ready to draw upon.

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## Forms for Concrete Building Construction

From an article by Allan Graham in The Surveyor and Municipal and County Engineer.

The design of the form is usually left to the contractor, but the author believes that for efficiency as well as for his own protection, the engineer should set out some typical portion of the forms for the contractor's guidance.

It is not merely that a design is required for a specific case to support safely a certain volume of concrete, it is rather the problem of designing a set of forms which can be erected, taken down and many times re-used during the progress of the work.

A careful consideration of the type of centering, the kind of timber, how much to center at one time, and what clamps, bolts, nails, wire or strap steel should be used, will repay the trouble taken and result in better and more economical work.

Authorities place the cost of form work at anywhere from 20 per cent to 60 per cent of the total cost, so the chance of reducing this hindrance to the more general use of concrete ought to be closely considered. American construction firms have tried in many ways to reduce this cost, and to this end the forms are designed in the drawing office at a cost of 2 per cent and a saving of 10 per cent.

The author dwells upon the desirability of careful checking of measurements, to see that the concrete members are actually carried out as designed, and emphasized the necessity of close joints to prevent the mixture escaping, the remedying of cracks, the removal of forms, clamps, and nails to hold the forms together, the repair and re-use of form work, the importance of clearing forms of all sawdust, dirt and chips before filling with concrete, and the wetting of timber to prevent sticking.

Of timber he said: White pine, yellow pine and spruce are all excellent, and should be free from knots; not so dry as to swell and bulge and thus distort the forms, nor so green as to shrink with the same result. Hard surfaced sorts may be used oftener without dilapidation.

The timber must resist the weight or pressure when a considerable height of wet concrete is being poured, as in walls and columns. Many authorities calculate this pressure as a liquid of half its own weight, viz.: 75 lb. per cubic foot. For concrete in layers no calculation is necessary, as practice had proved that for beams the bottom boards should be 2 in.-2½ in. thick, with sides 1½ in.-2 in. thick. Column sides should be 1½ in.-2 in. thick. For walls 1½-in. boards are used. A more solid board will insure greater economy, as the form can be repeatedly used. For slab panels 1-in. stuff is the usual thing, but 1-in. boarding requires staying every 2 ft.; 1½-in. boarding requires staying only every 4-5 ft.

Studs of adequate size should be spaced so as to prevent the boards between them from springing. They may be 2-in. x 4-in. to 2-in. x 6-in., if not used beyond 2-ft. x 3-ft. centers; 3x8 in. may be spaced about 4-ft. 6-in. centers; 4 in. x 10 in. at from 6-8-ft. centers; 6-in. x 12 in. from 8-ft.—10-ft. centers; but the spacing of supports must be governed by the nature of the weight coming upon the boards.

Of camber, Mr. Graham says: "It is necessary to give beams a camber of at least ⅛ in. in 5 ft.; i. e., $\frac{1}{480}$ of the span. This generally comes out during the ramming and tamping of the concrete and in the squeezing of the wedges. After the filling, the beams should be examined to see if the camber has come out, so that it may be again secured by tightening up the wedges before the concrete has set. In cases where a great deflection was found in the beams, the failure of the supports to the studs has been the root cause, due probably to soft ground. So judgment should be used to see that the sole plates under the supports are large enough to distribute the load safely over a sufficient area."

All timber supporting floors should be calculated for deflection rather than strength. Sanford E. Thompson's calculation for strength is quoted:

(1) Weight of concrete with reinforcement, 154 lb. per cu. ft.

(2) Live load: slabs, 75 lb. per sq. ft.; beams, 50 lb. per sq. ft.

(3) In calculating beams, planks, joists, use as the coefficient in the deflection formula a mean between the value for a beam fixed, $\frac{5}{843}$, and a beam supported, $\frac{1}{384}$. This average amounts to $\frac{3}{384}$. Then the deflection $= \frac{3}{384} \frac{W l}{E I}$, where

W = total weight or load (in lbs.),
l = length of span (in inches),
E = elastic modulus = 1,300,000,
I = moment of inertia.

The moment of inertia is, of course, $I = \frac{b d^3}{12}$, where d = depth and b = breadth (in inches).

He limits the deflection to ⅛ in.

For struts the allowable compression stress must be reduced in proportion to their slenderness. If we assume them to be in a condition intermediate between pin-connected and fixed because of their flat ends, the values for spruce or fir may be taken as in the following table, wherein

l = unsupported length of strut in inches,
g = gyration radius of strut in inches,

g being equal to $\frac{d}{\sqrt{12}}$ for square struts, and to $\frac{d}{4}$ for round struts, where d is the diameter (in inches).

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Ratio of $\frac{l}{g}$ | 60 | 75 | 90 | 105 | 120 | 135 | 150 |
| Value of allowable compressive stress. | 960 | 900 | 825 | 675 | 450 | 410 | 340 |

*Road and Street*
*Monthly Issue*

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(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies

**Waterworks and Hydraulics—2nd Wednesday**
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power

**Railways and Govt. Works—3rd Wednesday**
(a) Excavation and Dredging (c) Harbors and Docks
(b) Rivers and Canals (d) Railway Construction

**Buildings and Structures—4th Wednesday**
(a) Buildings (c) [illegible]
(b) Bridges (d) Miscellaneous Structures

Volume L. CHICAGO, ILL., AUGUST 7, 1918 Number [illegible]

## Change the Title of County Surveyor to Managing Engineer or County Manager

This journal was the first, we believe, to suggest that the "city manager plan" be applied to counties, making the county engineer the county manager. J. B. Thompson, civil and managing engineer of the Stanford Vina Ranch, Stanford University, has shown real initiative by urging the Governor of California to recommend a revision of the laws so as to give greater managerial power to county surveyors. We quote from "The Monad," the journal of the American Association of Engineers:

> Mr. Thompson is advocating to the Governor and others a revision of the California laws relating to the operation of county business and construction work with particular reference to highway work. He suggests delegating to the present executive charge of all county managerial affairs in construction, maintenance, purchasing supplies and operation of all roads, bridges, buildings and equipment, subject to the general supervision of the Executive (County) Board, retaining the Managing Engineer as an elective office.
>
> The proposed plan is in line with the City Manager Plan, which is rapidly demonstrating its usefulness by popular approval. The plan is similar to the new Illinois law whereby County Highway Superintendents (engineers) are appointed under civil service to perform the executive and construction work heretofore handled, or rather mishandled by county supervisors. Mr. Thompson's plan for California counties can have no stronger proof of its necessity and usefulness than the results which have been obtained by a similar plan in Illinois. The service of Highway Engineers in co-operation with the State Highway Department has resulted in marked improvement in the application of public funds to road construction, in efficiency and in 100 per cent on the dollar economy in Illinois. The public have seen this and have become more ready and liberal in voting to undertake highway improvements. Illinois is being pointed out as the [illegible].

Mr. Thompson would have improved his plan had he gone farther in adapting the "city manager plan" to county needs. The county manager should not be elected, but should be appointed by the Board of County Commissioners. The Commissioners should have their present functions reduced to those corresponding to the duties of a board of directors, leaving to the county manager all the executive functions.

There are 2,800 counties in America, 1,700 of which have county surveyors or engineers. Many of these are mere politicians and not surveyors at all. One of the first steps that engineering societies should take should be the driving of incompetents out of positions as county surveyors. Coincidentally there should be secured substantial increases in the salaries of county surveyors, so as to attract and hold men of ability. The final step should consist in making the county engineer the manager of the county.

## Why City Engineers Should Have Charge of Street Cleaning and Repairs

In most large cities street cleaning and pavement repairs are not under the direction of the city engineers. This is an economic mistake. Mayor Davis of Cleveland not long ago gave his approval to a plan outlined by City Engineer Hoffman for the systematic repairing of streets radiating from the heart of the city. The city engineer is to be placed in charge of all street repairs. Let Cleveland go one step farther and place all street cleaning also under the control of its city engineer, and it will secure a unity and economy of street maintenance not otherwise possible. The cost of street cleaning is largely dependent upon the character and condition of the pavements. Since the object is to secure the minimum annual cost of investment and maintenance combined, and since maintenance (in its economic sense) includes street cleaning as well as repairs, it is evident that this problem in unit costs can be correctly solved only when all the factors are under the control of one man.

If city engineers in every city, aided by other civil engineers, will seriously and sedulously attempt to convince the mayors and city councils of the wisdom of centralized control of all street work, it will not be many years before such control will be given to city engineers. The result will be marked economies both in repairs and in cleaning of city streets.

# Some of the Things the Engineering Council May Accomplish

We have at last, in the Engineering Council, an organization for presenting to legislators and others the best judgment of engineers on matters of public concern. Starting in a modest way, the Engineering Council is evidently destined to find its activities increasing steadily in number and in scope. Few that have not given much thought to the relation of the engineer to the public would be apt to realize the magnitude of the public field that should be tilled by engineering effort.

Engineering is the application of science in the solution of economic problems. If, however, engineers are to perform their functions completely as economists, they must not merely "send a message to Garcia," but must go in person to "Garcia"—the public. Most men are so constituted that it is almost futile to address them merely with written or printed words. They must be talked to with the living tongue, if the best results are to be achieved. Particularly is this true where radical departures from precedent and custom are involved.

As its first and greatest function the Engineering Council must convince the public that engineers are trained, practical economists. This involves making it clear that applied science of every sort is engineering. Once the public comes to an appreciation of the full scope and character of the work of engineers, half the difficulties now encountered in trying to direct public action will have been overcome.

The following are a few of the things to which the Engineering Council should eventually direct its attention:

1. Advertise engineering colleges, and secure larger state appropriations for state universities.
2. Give publicity to the achievements of engineers.
3. Secure passage of laws making it compulsory to employ trained engineers for public positions in which engineering knowledge is essential to the highest efficiency.
4. Secure appropriations for scientific researches of all kinds.
5. Secure revision of laws that debar engineers from architectural practice.
6. Secure laws that debar untrained men from assuming the title "engineer."
7. Secure laws that will effect more equitable distribution of assessments of cost of public works, such as pavements, sewers, etc.
8. Spread the gospel of the science of management, and oppose legislation that restricts or prohibits "payment in proportion to performance."
9. Support the "short ballot" and the "city manager" form of city government.
10. Support the private corporation system of organization and management as applied to cities, counties, states and Federal Government; including the "budget system," unit-cost keeping, the "requisition system," monthly balance sheets, detailed expense statements, and all modern accounting methods.
11. Secure revolution of methods of appraising property for taxation, substituting scientific engineering appraisals for the present haphazard guesswork.
12 Support the Torrens' system of real estate recording and transfer.
13. Educate the public to the economic advantages of metering city water.
14. Ditto as to treating water for elimination of disease germs.
15. Ditto as to street flushing.
16. Ditto as to mosquito elimination.
17. Ditto as to all other sanitary engineering.
18. Oppose labor union restrictions as to daily output and as to limitation of apprentices.
19. Secure larger appropriations for geological, topographical, hydraulic and coastal surveys.
20. Secure adequate salaries for engineers in public employ.
21. Secure much higher salaries for engineering teachers.
22. Secure greater co-operation among technical societies.

The list above given is indicative rather than exhaustive. It serves to indicate both the extent of the field and its diversified character.

# Engineering Students Exempted from Draft

A year ago Engineering and Contracting began editorial protest against the drafting of engineering students. Eventually other engineering journals joined the protest and finally a partial exemption was secured; the students whose proficiency ranked them among the "upper third" of their classes were exempted. We pointed out that this third of a loaf was not only little better than no loaf at all, but that it was not a reasonable ruling, particularly in view of the dwindling attendance at engineering colleges. We are now glad to be able to record a ruling by Provost Marshal Gen. Crowder that exempts from active service all engineering students.

Following is the ruling, known as section 151, S. D. R.:

> Under such regulations as the Secretary of War may prescribe, a registrant who is regularly enrolled in a school approved by the War Department committee on education and special training, and is pursuing a full time course leading to a degree of bachelor or higher in medicine, engineering, physics, chemistry and other technical subjects essential to the prosecution of the war, or who is an indispensable teacher in such courses, or who is engaged in the training of army personnel, may enlist in the enlisted reserve corps. Hereafter, on presentation by the registrant to his local board of his certificate of enlistment such certificate shall be filed with the questionnaire and the registrant shall be placed in Class 5 on the ground that he is in the military service of the United States.

# "A Street Ought to Be Built Like a Hospital Floor"

For years this journal has contended that city pavements should be so hard and smooth that they can be washed like a floor, and kept free of germs. We are glad to note that others are coming to the same conclusion. The health commissioner of Cleveland, Ohio, R. H. Bishop, Jr., M. D., recently said:

> The conditions of this warfare are not satisfied when a broom is passed across the irregular surface of some worn-out pavement, leaving the interstices filled with moist and decayed filth. A street ought to be built like a hospital floor, with a uniform, non-adhesive surface, so drained that the application of water from a flusher will wash every particle of filth from its moorings and carry it clear to the sewer without interruption.
>
> The workingmen who make up the population of congested localities deserve the best that the municipality can do for them. The first thing I would suggest would be the wholesale tearing up and resurfacing of every battered street in the populous districts. The objection that better public improvements would be reflected in higher rents, thereby compelling the poor man to move to more poorly paved streets, is not valid because our paving program includes all streets. Dr.

[illegible]

Mr. Bishop has put the matter none too strongly. Streets should be made to be flushed, and they should be flushed clean every day or every few days depending on conditions. Infantile paralysis, "colds" and lung diseases are all undoubtedly spread as part of the dust that is blown about. Knowing this, it becomes the duty of civil engineers to persuade the public to authorize the flushing of all streets, and, to this end, the laying of pavements "built like a hospital floor."

## What Matters if Indiana Goes Roadless? The Court Must Have Three Months' Rest

The Supreme Court of Indiana, through its failure to decide on the constitutionality of the state highway law, has set back all state road work in Indiana just a year. The court has gone on a three months' vacation. When it returns in the fall, it will be too late to start any road work. If there is any public spirit in Indiana, the Supreme Court should be made to feel its effect; for this is not a case of rebellion at the decision of the court but at its failure to render a decision.

A lower court had declared the new state highway law unconstitutional, and the highway commission had been enjoined from road building. A prompt appeal was made to the State Supreme Court and the public was entitled to a prompt decision. It got a prompt decision from the court—a decision to take a three months' vacation. Every newspaper in Indiana should voice its opinion on this decision.

## Tractive Resistance of Industrial Trucks with Small Wheels

There have been many tests of tractive resistance of vehicles having large wheels, but tests on small-wheeled vehicles have been few. Industrial trucks for use in shop yards, freight stations, etc., have small wheels, usually about 16 in. diameter. What is their tractive resistance on different roadways?

The Santa Fe Ry. recently conducted tractive tests on electric industrial trucks and trailers, and the resistances while in motion (3 miles per hour) were approximately as follows, in pounds per ton of 2,000 lb., including the weight of the truck and trailer.

| | Lbs. |
|---|---|
| Cinder road | 110 |
| Oiled cinder road | 75 |
| Concrete road | [illegible] |

The foregoing tests were made with a loaded electric truck pulling one loaded trailer on the cinder road and four loaded trailers on the concrete road. The truck weighed 2,200 lb. and was loaded with 2,000 lb. (although its capacity was 4,000 lb.) and it had rubber-tired wheels 15.5 in. diameter with a 3-in. tread. A trailer weighed 400 lb. and was loaded with 2,000 lb. Its rear wheels were 16 in. diameter and its two front castor-wheels were 8 in. diameter, all with steel rims. To start load on the cinder road took a pull of about 2.4 times as great as to keep it in motion. To start the much greater load on the concrete road took a pull of 3.2 times as great as to keep it in motion.

Tests on the trailers alone loaded with 2,000 lb. each, making a gross load of 2,400 lb. per trailer, gave the following tractive resistances in pounds per ton of 2,000 lb. while in motion:

| | A | B |
|---|---|---|
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |

A relates to the trailer with roller bearings, and B with common bearings. It required about twice the pull to start a trailer as to keep it moving.

As a result of these tests about 2.5 miles of concrete roadways were built at the Topeka shop yards which cover 120 acres, resulting in a great saving in hauling costs between the shop buildings and storage platforms, sheds, etc.

## The Waste in Municipal Printed Matter

One of our contemporaries calls attention to the waste in municipal printed matter. Thus in one issue of the Philadelphia "Public Ledger" there were 10 column feet of detailed expenditures made by the various city departments, all of it stuff that scarcely anyone would read, or, reading, make the slightest use of. Yet the government is calling upon newspapers to reduce their size, cut out sample copies, and the like! Of course, there are laws compelling cities to publish such matter as that in the "Ledger." But isn't this a "mighty good" time to repeal a few thousand such laws? When individuals and corporations are eliminating every expense possible, municipalities should do likewise.

## The Unfair Public

There is an old saying to the effect that the "voice of the people is the voice of God," but it is not given much credence by public works contractors. Just now this "voice of God" is telling contractors that after they have signed public works contracts the public has the right to raise the price on one of the things essential to the execution of the contract, namely, rail transportation. The railroad administration has been asked to give to highway contractors relief from the increase in freight rates ordered subsequent to the signing of the contracts. Was relief granted? Not a bit. The "voice of God" reminded the contractors that it was "not theirs to reason why—theirs but to do and die." The Government needs money. What matters if a few hundred contractors are ruined in the process of getting it?

The editor speaks with feeling, for he experienced precisely this same sort of public unfairness some twenty years ago when the state of New York passed an eight-hour law. Every public works contractor in the state was forced suddenly to work his men two hours less each day than had been the custom; for, although the law was not retroactive in theory, it was so in practice. All workmen struck for an eight-hour day, as soon as the law was passed, and they got it—at the expense of every public works contractor in the state. The contractors protested. The "voice of God" replied: "Didn't you know that you were taking chances of having to pay higher wages when you signed your contracts?" We did. But what we did not know was that in dealing with the public we would be dealing with a perfectly unfair "owner."

# Method of Building Earth Roads in Kane County, Illinois

By GEORGE N. LAMB,
County Superintendent of Highways.

Earth road building is worthy of the most careful study by the road engineer. This study should embrace the equipment with which to do the work as well as the methods and materials concerned in the operations. Several years' experience in this class of work in Kane County has afforded an opportunity for such study with results which may be of some interest to others.

**The Road Building Equipment.**—The county owns three complete road building outfits. Two of these are earth road units, each consisting of a 40-HP. Avery gasoline tractor, a heavy No. 10 road grader, a scarifier, a three-way road drag, a ¾-in by 18-ft. chain and a ⅝-in. by 50-ft. steel cable; also a gasoline and oil supply wagon, a tool box and a low four-wheeled truck for carrying the drags and small tools. The grader, scarifier and drag were furnished by the Austin-Western Co. The corresponding machines in the two outfits are of the same make and size. Each outfit is operated by a force consisting of an engineman and a grader man.

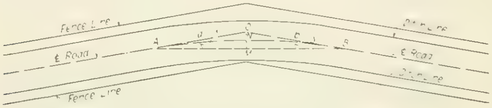

Fig. 1—Diagram Furnished Engineman to Show Method of Laying Out Short Curves.

Directions for Laying Out Curves on Small Angles: 1. Find the point O where the center lines from each direction intersect. 2. From point O, measure off equal distances, OA and OB. 3. Locate M by sighting on a straight line between A and B. 4. The point N on the curve will fall midway between O and M. 5. The distances ax and by (the central points on OA and OB) equals ⅛ the distance OM. 6. Increasing or decreasing the distances OA and OB will increase or decrease the distance ON.

**Surveys and Plans.**—In the majority of cases, no surveying is done except to line up a row of lath about 2 ft. outside each ditch line. On straight work, these are placed 150 to 200 ft. apart and at equal distances from the center line of the finished road. On difficult sights, these lath are sighted in with a transit; but usually the engine man does this work himself without an instrument. These lath can be readily seen from the engine and enable the driver to cut his ditches true to line. The engine man is furnished a blue-print showing a simple method of laying out short curves (see Fig. 1). These he also lines up "by eye."

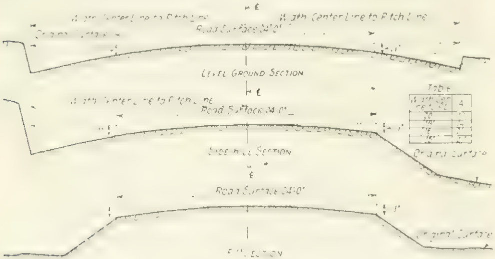

Fig. 2—Kane County Standard Cross Sections for Grading Earth Roads.

The grade line also is usually determined by the engine man. In places, however, where an old "pike" exists, it is usually too high and too narrow and very crooked. It must be widened and straightened by filling in here on one side, here on the other side, here on both sides, here by cutting down the old roadbed and here by bringing in extra dirt from the sides. Such work is sometimes cross-sectioned and a profile made. In these cases, the lath along the side ditches are set true to grade as well as to line and the graderman obtains his levels by sighting across the crown from one lath to the opposite one.

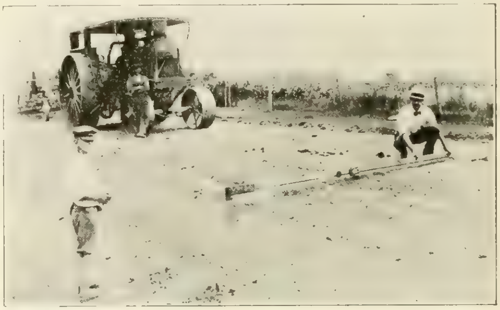

Fig. 3—Curvature Board and Method of Using It. The "Level" Bubble Is Observed Just to the Left of the Center of the Board.

So far as possible, earth roads are graded to a standard section 24 ft. between shoulder lines. The ditch lines are of varying widths and the ditches of corresponding depths as indicated in the drawing, Fig. 2.

Each outfit has a curvature board (see Fig. 3) which is 12 ft. in length and has two perpendicular arms. These arms are placed at the outer end and at the center of the board and are of such length that, with the board level, they will conform to the standard cross section of the road surface. In using the board, the free end is placed at the center line of the finished road; the arms will rest on the surface and will enable the men to determine whether they have reached the ideal cross-section. As the curvature of our standard earth section differs from that of the standard gravel road section, the boards have two sets of arms hinged for convenience.

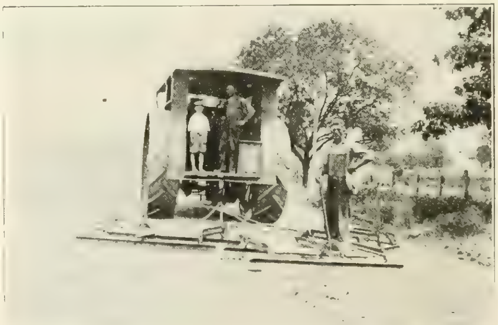

Fig. 4—Three Way Drag and Finishing Process.

**The Operations.**—Before starting a piece of work, it is often necessary to remove trees or brush along the roadside. If the trees are small, the large chain is hitched around the trunk and the engine pulls them out by the roots. If they are large, the cable is attached as high as it will reach and the engine pulls them over, roots and all. It is often necessary to do some cutting at the roots and sometimes a charge of dynamite is used under the roots as the engine pulls.

In starting a new piece of work the first operation is to dispose of the sod. Starting at the outer ditch lines the grader blade is set to make a shallow cut and shave the sod toward the center of the road. As the subsequent cuttings are brought in from the ditch lines the sod is buried by fresh dirt and is well beaten down by the weight of the engine. No sods whatever should show in the completed roadway.

The surface is finished with a circular crown. On sidehill work all the cutting is made on the up-hill side and the dirt carried to the opposite shoulder. It is often necessary to employ teams with wheeled scrapers to transport the dirt loosened by the grader to places where sufficient dirt cannot be secured along the sides. By crowding the end of the blade into the bank and undermining the dirt to be removed by teams, we have excavated in side cuts as deep as 10 ft. or more.

The grader will give the road the true shape but not a really "finished" surface. To secure this surface we use the three-way drags (see Fig 4). These fill up all depressions and compact the dirt. The engine, with the spuds or cleats removed from the wheels, pulls the drags and gives the road surface an additional rolling, leaving it smooth, firm and as nearly waterproof as possible. A few extra rounds with this equipment give the road a permanency which cannot be secured with the grader alone. The writer has personally motored over some of these county-built earth roads after heavy rains, and where they have been well maintained with a road drag, there was not mud enough even to suggest going into second speed.

**Advantages of County-Owned Machinery.**—Under the Illinois law, there are many advantages in county-owned machinery. Chief among these is the fact that the machines are operated throughout the entire working season and do not depreciate from non-use; also the operators employed steadily at the one class of work and under skilled supervision, not only become expert but show constant improvement in quality and efficiency of workmanship.

The ordinary township is too small a unit to own and operate modern heavy grading equipment with economy, and would not have sufficient work to keep it employed continuously during the season.

Each county unit will serve several townships during the season. The earth roads built by them may be said to be model roads, for both the methods and the results are imitated by the township officials where roads are built by their own outfits on a smaller scale. The marked improvement in township-built roads is apparent.

**Costs of Earth Road Grading.** So much depends on the topography, the natural condition of the soil and the weather that the cost of grading an earth road to standard cross-section may vary from $50 to $200 per mile. The cost of a few roads, taken at random, was as follows:

COST OF EARTH ROADS IN BLACKBERRY TOWNSHIP IN 1917.

| Road No. | Width, ft. | Length Improved, miles | Total cost | Per mile |
|---|---|---|---|---|
| 11 | [illegible] | [illegible] | [illegible] | [illegible] |
| 15 | 36 | 0.7 | 53.11 | 75.88 |
| 20 | 36 | 0.5 | 30.94 | 61.88 |
| 21 | 36 | 0.3 | 30.04 | 100.10 |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

The above costs do not include depreciation or repair bills.

Following is the average daily costs for the present season:

| | Per day |
|---|---|
| Engineman | $5.37 |
| Graderman | 3.87 |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| Total | $14.87 |

## The Best Road Investment

In his presidential address at the last annual meeting of the Western Society of Engineers, Mr Charles B. Burdick called attention to the tendency to overestimate the importance of new highway construction and to minimize the question of road maintenance. He stated that it is often incorrectly assumed that the abominable macadam roads now existing over large areas in the middle west are perfectly useless, and that good road service must await the millennium of a universal hard road system, whereas a comprehensive, intelligent maintenance and construction program, like that recently adopted in Wisconsin, would produce at least a fairly good road system almost at once. Expenditures for new hard road surfaces could be made from year to year on these roads where the investment would produce the largest return in maintenance saved. The application of engineering principles to this problem, continued Mr. Burdick, will disclose the fact that nearly every type of road has its proper place; that the best road investment is a proper balance between fixed charges upon the investment and the cost of maintaining the road in good repair. The amount of traffic vitally affects this problem and, correctly solved, the so-called hard roads would be indicated upon the main lines of communication and there would be an important place for old road types, slightly modified from the days of horse-drawn vehicles.

## Causes for Disqualification of Bidders on Kentucky Road Work

The new specifications of the Kentucky Department of Public Roads for the construction of state roads, issued last month, contain the following clauses regarding disqualification of bidders:

A bidder will be disqualified and his bid not considered for the following causes:

(a) Interest by the same bidder in more than one proposal.

(b) Collusion with other bidders.

(c) Lack of responsibility. No bidder will be considered responsible who has failed to carry out any contract entered into with the state of Kentucky or the fiscal court of any county of said state within the preceding 5 years unless the responsibility for his failure to do so lies with the state or county.

(d) Lack of experience or adequate capital. Evidence of experience, ability and financial standing as well as a statement regarding plant and machinery available may be required of any or all bidders.

(e) Substantial evidence of dishonesty or lack of good faith and intent to do work according to the plans and specifications therefor.

Unbalanced proposals (proposals in which the price bid for some items are out of all proportion to those bid for others), will be rejected as irregular.

# Recent Practice in Construction of Tar Surfaces and Pavements

An interesting outline of American and English practice in the construction of tar surfaces and tar macadam and concrete was given by Prof. Arthur H. Blanchard, Consulting Engineer, New York City, in an address delivered May 8 at the Canadian Good Roads Congress. An abstract of the address follows:

**Clearing a Road Before Tar Surfacing.**—Before constructing a tar surface on a broken stone or gravel road, every precaution should be taken to secure the best subdrainage which is practicable under the local conditions. All depressions, pot-holes, ruts or other irregularities should be filled with thoroughly compacted, tar-coated stone so that the whole surface of the roadway is even. All surplus dust must be removed so that the larger pieces of broken stone of the roadway surface are exposed, but without breaking the bond. This cleaning process is accomplished by the use of horse sweepers and fine bass brooms, with coarse fibre brooms and fine bass brooms, or by a vacuum process. If there is caked mud on the surface of the roadway, wet brushing will prove advantageous.

It is apparent that the character of the cleaned surface will be affected by the method which was used in the original construction of the roadway. If there be followed the practice of some English and American engineers in using large-size stone varying from 1 to 2½ in. in longest dimensions for the top course of a broken stone road, and if the stone be hard and tough, the desired surface can be easily secured. The surface of the large stones in such a roadway are easily cleaned by brushing, without the dislodgment of stones in the surface. A clean mosaic surface is of the utmost importance from the standpoint of the formation of a satisfactory bond between the broken stone and the tar. The maintenance of tar surfaces on wearing courses of large broken stone is economical, since after the tar surface wears away in spots the mechanically interlocked large stones will of themselves generally have sufficient stability to withstand the effects of traffic until retreated.

On the other hand, if the top course of a broken-stone road has been constructed of a product varying in size from ¼ to 1¼ in., it will be very difficult, if not impossible in the case of soft stone to secure an even clean surface. Even after thorough brushing, a film of impalpable dust usually covers the surface of the roadway. During hard brushing small depressions will probably be formed by the displacement of pockets of dust and the smaller sizes of stone. Furthermore, the wheels of vehicles may adhere to the tar and thus tear up the small mineral matter adhering to it. As soon as the tar surface wears out in spots, rapid disintegration of the exposed broken stone or gravel surface, with the consequent formation of potholes, is apt to occur.

**Applying the Tar.**—If a tar surface is to be constructed on a new broken-stone or gravel road, or on one which has just been resurfaced, the tar should not be applied until the crust has had time to consolidate under the action of traffic and with the aid of the binding action of dust and moisture. If it be impracticable to postpone the surface treatment, special care should be taken to secure a maximum consolidation of the crust of the roadway by puddling and rolling.

When the tar is applied, the roadway surface should be bone dry. If the surface is damp, it will be difficult to secure a good bond. Distribution of the tar is accomplished by two methods, (1) flow by gravity, (2) mechanical pressure.

The use of gravity distributors has not been developed to its fullest extent in America, in that the use of mechanical brushes, or the brushing of the material into the road by hand brooming, has never been adopted extensively. By brushing after gravity distribution, it is possible to distribute uniformly ¼ to 1/5 gal. of tar per square yard. In some cases, when the distribution is accomplished by hand brooming, the adhesion of the material to the road metal is as good as when the material is applied under pressure. The advantages claimed for pressure distributors are the following:

Aid in cleaning the surface of the roadway; even application; distribution of small amounts per square yard; satisfactory adhesion obtained between the tar and the surface of a clean, dry roadway; and rapid, economical distribution.

As a general rule, from ¼ to ½ gal. per square yard is used for the first treatment, preferably in two applications. The amount applied per treatment depends upon the kind of tar, the character and condition of the surface, and the details of the method of application. For example, a smooth surface composed of large-sized, tough, hard stone, well compacted by traffic, would require from 0.25 to 0.45 gal.; for a somewhat rough surface of stone having a medium toughness and hardness and recently resurfaced, it would be necessary to use from 0.35 to 0.5 gal. per square yard to form a satisfactory thin tar surface.

The superficial coat of tar is usually covered with either coarse sand, fine gravel or stone chips varying from ⅛ to ½ in. in longest dimension. Material containing clay should not be used, as disintegration may result by the emulsifying of the clay and water on the tar surface. The amount of sand, stone chips or gravel used per square yard depends upon the quantity and kind of the tar and the character of the surface of the roadway. From 5 to 20 lb. per square yard have been used satisfactorily for thin tar surfaces; 5 to 12 lb. for from 0.1 to 0.25 gal. of tar per square yard; 10 to 17 lb. for 0.25 to 0.35 gal.; and 15 to 20 lb. for from 0.35 to 0.5 gal.

**Cost Data for Tar Surfaces.**—Under normal conditions, with labor and foreman at $2 and $4 respectively for an 8-hour day; team, $5 per day; refined tar, applied, 7 to 9 ct. per gallon; and top covering, $2 to $2.25 per ton, delivered; the cost of tar surfaces, using from 0.25 to 0.4 gal. of tar per square yard, will vary from 4 to 8 ct.

**Tar Macadam Pavements.**—A tar macadam pavement is one having a wearing course of macadam with the interstices filled by a penetration method with a tar cement.

Usually tar macadam pavements are constructed on broken-stone or gravel foundations. In cases where traffic conditions require rigid foundations, or where materials satisfactory for cement-concrete may be secured at a much lower cost than broken stone, cement-concrete foundations have been used and have been found to be satisfactory and economical. The more general use of cement-concrete foundations is advisable on trunk or other highways where traffic is likely to increase rapidly both in amount and weight. When it is necessary to construct a more durable type of wearing course than tar macadam, the cement-concrete foundation previously constructed proves a valuable asset and allows reconstruction to be accomplished economically.

In order that road metal should interlock during compaction and thus provide a stable wearing course, a proper angularity is an important prerequisite. The road metal should not contain over 5 per cent of particles having small acute angles, nor should the product contain slivers. Road metal which has a rough or coarse grain or pitted surface is preferable to material with smooth or glassy surfaces, as the tar cement adheres more satisfactorily to the former than to the latter. Cleanliness is an essential quality of road metal for the wearing course of tar macadam pavements. It is difficult and usually impossible to secure a good adhesion of the tar cement to road metal which is not clean.

In the construction of tar macadam pavements it is desired to secure (1) a stable wearing course consisting of broken stone or similar material thoroughly rolled so that it will be well compacted and keyed together, and with the several sizes of material uniformly distributed; and (2) a uniform distribution and penetration of the tar within the upper 1½ to 3 in. of the crust.

Several methods of construction have been devised with a view to meeting the above prerequisites. Careful supervision, based on experience, is necessary to prevent non-uniformity in the density of the wearing course of broken stone and in the amount of tar applied per square yard. It is evident that uniform application of the tar will depend upon the method of distribution employed. In using vehicular distributors, one cause of uneven distribution of the tar is overlapping of applications. The use of strips of tar paper or wrapping paper, from 3 to 5 ft. in width, placed at the edge of an application, has prevented sections of the wearing course receiving double the amount of tar cement specified.

A typical American method of construction is as follows: The metalling of the wearing course is a uniform product of about 1 or 1½ in. in size or a product similar to or larger than one passing over a 1½-in. and through a 2½-in. screen, and the voids in the upper part of the wearing course are filled after the tar cement is applied. Practice varies with reference to the amount of rolling of the wearing course prior to the application of the tar cement. For traffic medium or heavy in weight and amount, the best results have been secured by thoroughly rolling the road metal and thus securing maximum interlocking of the particles and thereby securing the highest degree of stability practicable by this method. The tar cement is applied in an amount varying from 1½ to 2 gal. per square yard, after which ⅝-in. stone chips, or a product similar to one passing a ½-in. and through a 1-in. screen, is spread and thoroughly rolled. Usually the surface is then broomed with stiff brooms, removing the excess loose broken stone, and another coat of tar cement, from ⅓ to 1 gal. per square yard, is applied, covered with a layer of stone chips, or pea gravel, and rolled.

**Cost Data for Tar Macadam.**—The cost of tar pavements built by penetration methods varies with the amount and kind of tar cement and road metal used and the method of construction employed. An average cost, using 6 to 8 in. of compacted broken stone and a total of 2 to 2¾ gal. of tar cement per square yard, varies from 25 to 40 ct. per square yard in excess of the cost of waterbound broken stone roads, or from 70 ct. to $1.25 per square yard.

**Tar Concrete Pavements.**—A tar concrete is one composed of broken stone, broken slag, gravel or shell, with or without sand, portland cement, fine inert material or combinations thereof, and a tar cement incorporated together by a mixing method.

Tar concrete pavements may generally be grouped into three classes. The essential characteristics of these classes are as follows:

Class A—A tar concrete pavement having a mineral aggregate composed of one product of a crushing or screening plant.

Class B—A tar concrete pavement having a mineral aggregate composed of a certain number of parts by weight or volume of one product of a crushing or screening plant, and a certain number of parts by weight or volume of sand, broken stone screenings or similar material, with or without a filler.

Class C—A tar concrete pavement having a predetermined, mechanically graded aggregate composed of broken stone, broken slag, gravel or shell, with or without sand, portland cement, fine inert material or combinations thereof.

There is ample evidence at hand that tar concrete pavements of Class A may be constructed without danger of litigation proceedings.

The history of litigation cases indicates that the construction of unpatented tar concrete pavements of Class B on a large scale will in all probability lead to an infringement suit.

With the exception of the class of tar concrete pavements having mineral aggregates similar to that covered by the Topeka decree, the extensive use of nonpatented tar concrete pavements of Class C will usually lead to litigation proceedings.

Many failures have occurred due to laying tar concrete pavements on weak foundations. Of the more common types of foundations, satisfactory results have been obtained under medium traffic with thoroughly filled and compacted broken stone and tar-concrete foundations. Cement-concrete foundations should generally be used.

Under Class A, two types of pavements will be considered. The most efficient type, as laid in America, has a mineral aggregate which will comply with the following requirements:

All of the broken stone or broken slag shall pass a 1¼-in. screen; not more than 10 per cent nor less than 1 per cent shall be retained on a 1-in. screen; not more than 10 per cent nor less than 3 per cent shall pass a ¼-in. screen.

This aggregate, for small jobs, may be mixed with hot tar cement by hand methods. Usually, however, mechanical heating and mixing plants should be used. In a complete plant for the manufacture of tar concrete, the aggregate is carried by bucket elevators, to rotary dryers, where it is dried and the dust exhausted. From the dryer the aggregate is raised by elevators to storage bins. When required the aggregate is drawn from the bins to a weighing device, and from there deposited into a mixer. Such plants are also equipped with tar cement heating tanks and weighing buckets. A plant of this type should have a capacity of from 800 to 1,000 sq. yd. of 2-in. wearing surface per day. For the type of tar concrete under consideration, it has been found that the tar mixture should contain between 5 per cent and 8 per cent of bitumen.

An important detail of laying is thorough rolling. An even surface and adequate compaction, with thorough interlocking of the particles of broken stone, may be readily obtained by the proper use of a tandem roller weighing between 10 and 12 tons.

Many methods have been developed for the application of the seal coat of tar. It has been found that seal coats of from ½ to 1 gal. of tar cement per square yard are distributed most uniformly by the use of hand-drawn gravity distributors, followed by a squeegee.

The average cost of this type of tar concrete under normal conditions, when laid as a 2-in. wearing course, should be from 25 to 40 ct. in excess of a waterbound broken-stone wearing course of the same thickness.

The second type of tar concrete of Class A is the two or three-cornered pavement in which each course consists of one product of a crushing or screening plant. The excellent tar slag concrete pavements which have been laid in England since 1903 are of this type. Although used by various municipalities, the largest yardage of this type has been constructed by Tarmac, Ltd. One of the Tarmac plants is located at Wolverhampton, adjacent to that of a company producing large qauntities of blast-furnace slag. The large molds of slag are transported by small cars from the iron works on a narrow-gage track and dumped near the Tarmac works. These large blocks, while still warm, are broken by sledgehammers to a size suitable for the crusher. After it is crushed and screened into sizes varying from ¼ to 2½ in., it is mixed with a tar compound. Since the slag is warm even after it has been crushed, no heating preliminary to mixing is necessary.

Although in some cases two courses of tar slag concrete are used, usually more than two layers of tar-coated slag are employed, as was the case with tar slag concrete pavement laid at Brighton-on-Sea. The details of construction follow:

On a well-compacted gravel foundation was spread a scattering of tar-coated slag chips. The bottom layer was composed of 2½ in. of compacted 1¼ to 2½-in. tar coated slag. The second course consisted of 2 in. of compacted ½ to 1½-in. tar-coated slag. The third course was composed of a thin layer of ⅛ to ⅜in. tar-coated slag chips, which layer was thoroughly rolled. The pavement was finished by rolling a top dressing of uncoated fine slag screenings.

Tar concrete pavements of Class C, with mineral aggregates similar to the modern Topeka grading, were laid in Pittsburgh, Pa., about 1890. The pavement laid on Lang Ave. has been in service, with only nominal repairs, for the past 26 years. Many similar pavements were constructed in several cities of New England as early as 1885. Since 1913, tar Topeka pavements have been laid in several states throughout the middle west of the United States and also in cities of New England. Some of the best examples of this type of tar concrete pavement have been constructed with about 8 per cent of tar bitumen in the mix, and with a light seal coat of refined tar.

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**Plans Under Way for October Highway Association Meeting.**—A meeting of the officers and directors of the Highway Industries Association was held at Lima, O., Aug. 5 for the purpose of formulating plans for the annual meeting to be held in Chicago the first week in October and to arrange for a joint meeting to be held under the auspices of the American Association of State Highway Officials and the Highway Industries Association. Questions of great importance will be discussed at both meetings. Plans and arrangements will be made at the joint meeting for a thorough co-operation with the State Highway Officials, so that the policies and legislation promulgated at that time may be pushed.

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# Method and Cost of Reducing Excessive Crown on a Macadam Pavement

By E. EARL GLASS.

Many of the older bituminous macadam pavements were built with the same high crown needed to properly drain the water-bound macadam road. This was not only unnecessary for drainage, but made the smooth, sloping surface dangerous by skidding autos and teams. Drivers naturally kept to the middle of the road so that it became practically a single-track and consequently subjected to excessive wear.

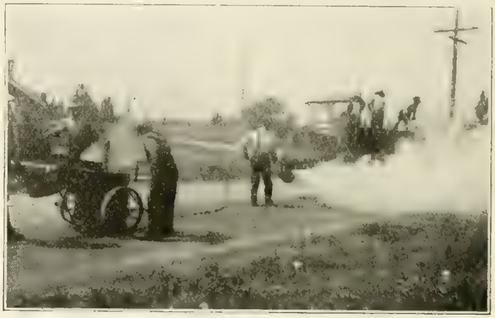

Fig. 1—Hand Oiling Outfit of Los Angeles County Road Department.

Such a condition was remedied when the Los Angeles County Road Department reduced the 10-in. crown in a section of the Lankershim Blvd. to 4 in. The traffic is principally passenger automobiles and the old bituminous macadam surface was in excellent condition, hard and smooth. The road was kept open to traffic by improving only one-half the width at one time.

A 4-ft. strip along the edge of the clean pavement was given a binder coat of hot asphaltic road oil with the hand oiling outfit shown in Fig. 1. No. 1 stone was spread upon the oil to a depth that left the rolled surface ½-in. below finish grade. In the same way two smaller sizes of stone were placed in parallel strips as shown in Fig. 2, leaving a 5-ft. space in the center bare. The stone was rolled by a 12-ton gas roller, then covered with screenings and wet and rolled until an excellent water-bound macadam was obtained, true to section and with only 4 in. crown. When the surface was dry, it was swept to expose the metal and the entire half width sealed with hot 90 per cent asphaltic oil, applied by a pressure spraying oil truck. This was covered with a light coat of clean granite screenings and the completed strip thrown open to traffic. An earth shoulder was thrown up by a road grader to protect the edge.

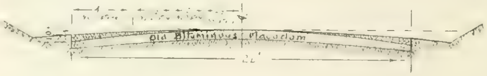

Fig. 2—Cross Section of Road.

The pavement has proven satisfactory in every respect. The length of the improvement was ½ mile. The cost was as follows:

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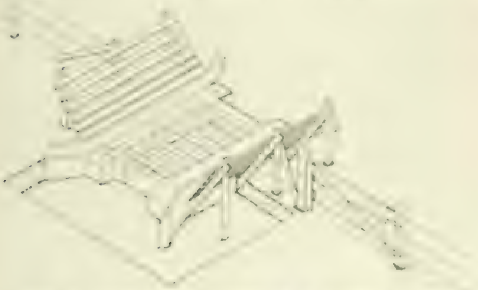
## Auto Crossing for Line Fences and Farm Entrances

A type of auto crossing employed quite extensively in western Kansas is shown in the sketch. The arrangement was designed by Mr. Petefish, County Engineer of Scott, Wichita and Greeley counties. It is used on a line fence where the travel is across fields, or in sparsely settled sections where gates are allowed on highways. It is also used to very good advantage on farm entrances. It is built on a similar plan to the cattle guards on a railroad. Where there is horse traffic to be taken care of, a gate is generally placed close to the crossing.



Type of Crossing Used Extensively in Western Kansas.

Very little form work is required in the construction, as the sides of the excavation for the two runways act as forms. After the runways have set, the center pit can be dug out to a depth of not less than 1 ft. Blocks can be placed in the runways when they are cast to provide spaces for the 2 by 4-in. guard bars across the pit. If possible, a drain should be placed in the bottom of the pit, running to some lower ground. This is unnecessary in the above counties, as the nature of the soil allows the water to soak into the ground.

## Store Door Freight Deliveries in New York City

A plan for eliminating the freight congestion at piers and railway terminals in New York City is to be put into effect Aug. 15. After that date all incoming shipments will be delivered direct from the terminals to the consignees without the formality of any notices of arrival. At present consignees are allowed a 48-hour free demurrage period. The entire mercantile district will be divided into zones and all trucks delivering the freight will leave from terminals with full loads to be delivered in one of the zones. Each truck will be registered and will be under the supervision of the city drayage director, who will have general supervision and control of the trucking of freight from the pier or freight station. He will be assisted by drayage supervisors, one at each pier. It is expected that the new system will result in a 30 to 50 per cent increase in the amount of freight that the railroads can handle. It is stated that after the system has been perfected in New York City it will be applied to all other cities in the United States.

## Cost Keeping System for County Highway Work*

By H. A. SEWELL

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The number and character of forms to be used in a cost keeping system for county highway work will depend largely on the size of the county and the method of handling the superintendence of road work; but there are certain elements or principles of any such system which will apply to all cases. These elements I will group under the heads (1) Authorization of Work, (2) Reports, (3) Segregation, and (4) Summary.

**Budget of Expense.**—The first element under authorization of work should be a well-considered budget of expense, based not upon the usual basis of "salaries or per diem," "contracts," "labor," "team work," "materials and supplies," "tools and Machinery," etc., as we generally find in the county budget; but rather upon the amounts to be allowed for all these items for construction or maintenance of each particular piece of road, or bridge, whether it be by contract or day labor, and, in addition, a fixed amount for overhead for the district or county, as the case may be, which cannot properly be charged to any particular stretch of road. No one realizes more than do I the difficulties of forming a budget under our present system of county bookkeeping, but after installing the rest of a cost keeping system it will yearly become an easier matter to formulate an adequate and well-balanced budget. After the adoption of the budget it should be rigidly adhered to, except in cases of palpable oversight or emergency.

**Authorization Blanks and Work Orders.**—Having adopted the budget, the next element of authorization is some form of "authorization blank," "work order" or "job sheet," to be delivered to each man in charge of road work, for each individual job, by his superior in charge of district or county, as the case may be. This blank should show in more or less detail the work to be done and the amount to be allowed for the work.

Closely allied with the "work order" is the "requisition." Agreeable to local conditions, it may be issued to the job foreman by his superior, or by the foreman himself upon the authority contained in the work ordered. The principal object of the requisition is to prevent haphazard and unregulated purchase of material and machinery and to show who received such material or machinery. Needless to say, neither the "work order" nor the requisition applies to contract work, as the contract and specifications are sufficient authorization of the work and the bond protects the county.

**Segregation of Expenditures.**—The second group of elements I have classed as reports. By this I mean the segregation of the expenditures of road money so as to show on what particular piece of road the expenditure occurred, and, further than that, if possible, the exact location and nature of the expenditure. The forms to be used for these reports, and whether they shall be daily, weekly or monthly, will again depend upon the magnitude of the work and local methods of handling the same. Another important factor in designing a report is the character, education and experience of the person making the report; and great care must be exercised in not making it so complex as to cause either of the alternatives, no reports, or the loss of a good road boss.

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The ideal place for the report would be on the claim vouchers or pay roll, as such a system would be simple and direct. Unfortunately, however, the vouchers and pay rolls used in this state are prescribed by bookkeepers and not by engineers, and no provision is made for segregation of time. Therefore the next best scheme is to design a system of report which may be properly segregated and distributed.

The report or reports should show the work order number of the job, the names of the foremen and workmen, the location and exact nature of the work, and the number of hours working time.

In case the foreman is allowed to requisition materials or tools for his use or take some from stock, he should be required to render a memorandum report of such transactions. On contract work the inspector should make the reports. Traffic reports should be kept on all maintenance work where possible.

**Distribution of Costs.**—There is a large group of elements to be considered under the head of segregation and distribution, as there are so many heads under which costs might be segregated. Here, however, we must follow our budget and distribute costs as nearly as possible according to the items outlined in the budget, leaving any other segregation desired as a sub-segregation under the main segregation, according to overhead and roads, to be recapitulated in the summary of costs. The reports having been made as simple as possible to be and still convey the necessary information, most of the work of segregation must be done in the office, and it may be carried as far as the accuracy of the data and the local conditions render advisable.

The first question to be decided is which items are to be considered as overhead expense and which are to be charged as road expense. It is my rule to charge every expense to overhead which cannot be directly traced to some particular road or group of roads, but is of general value to the district or county and may be (although not necessarily must be) of general use. Thus, small tools may be bought for and worn out by a patrol crew on a particular section of road, yet such tools are of general value and might be used elsewhere should occasion require, and would be charged to overhead expense, heading "Tools and Machinery." The headings and subheadings should cover the principal items of overhead and the remaining overhead items should be carried in miscellaneous columns, adjoined by a blank column to show cause of outlay. Sometimes one claim paid will be segregated under several heads in several columns. "Materials and supplies" purchased in quantity, which will ultimately be charged direct to the several roads, should be carried in a stock account and, when used, should be charged to the respective roads and the amount credited to the stock account. The extent to which these accounts need be subheaded will depend largely on the magnitude of the work accounted.

The items of road expense chargeable to the several roads direct are easily classified into labor and materials, and the subheads are familiar to all. Here, for convenience, the entire crews' time for a certain period of time, depending on the report interval, may be entered together as segregated by the reports, checked against the pay rolls. If possible, different classes of work readily measured by units should be segregated and the unit cost entered, as well as the entire cost of the class of work and of the whole section. For contracts the bid prices and actual costs may both be entered if desired. Engineering and inspection on any particular road should be carried in an engineering account and charged to that road or job in the yearly summary. Bridge work may well be carried in separate accounts in a bridge ledger and charged to the road on the yearly summary.

**Annual Cost Summary.**—Having segregated the various items for future reference, the next question is as how to make use of them. This is through the summary, preferably annual. In the annual report or summary the divisions of the budget should be closely followed, so as to show whether expenses overrun or fall short of the budget. This is for the information of the general public. In addition to this a recapitulation should be prepared, if possible, for the benefit of highway engineers, showing unit costs of construction and maintenance, based upon convenient units. On maintenance the most convenient unit is probably the mile; and by use of the traffic reports a convenient unit is cost per year per mile per unit of traffic.

The report should, if possible, contain a statement of assets in the way of machinery and tools, based upon their depreciated value at that time, and the difference between this statement and the one for the year before should be subtracted from or added to the tools and machinery account under overhead expense, according as the asset value has increased or decreased. Where a piece of machinery is finally junked and its asset value gone, its entire cost should have been absorbed by the overhead account.

### Cost System of Pend Oreille County.

The system which I have installed in the Engineer's office in Pend Oreille County is based on that provision of the law which provided that the County Engineer shall keep a record of the history of each road.

The authorization blanks consist of work orders and requisitions issued by the Supervisor to his respective foremen and by the Engineer for permanent highway maintenance. These blanks are printed in triplicate, the stub being retained by the Supervisor, the next division going to the Engineer's office, and the outside blank going to the foreman. In the case of a work order he keeps it, while a requisition is turned in to the person or firm providing the material or machinery, to be attached to claim vouchers. The Engineer files his for future reference. Certified copies of all contracts, of course, are filed in the Engineer's office, as required by law. In some cases small jobs of day work on construction or maintenance are let out to local parties on work orders. In such cases the work order numbers and classification of labor on the pay roll are usually sufficient to properly record the work, so it is not customary to require reports on such work.

All foremen employed on more than one job are required to turn in monthly industrial labor reports showing when, where and how all work is done. While at first sight the idea of having a separate sheet for each individual may appear cumbersome, it is simple for the foreman, and affords the exact information desired. It also is easily checked against the pay roll, and in a small county, at least, is easily handled in the Engineer's office by placing in a letter file for each month and segregating the various reports for entry in the ledger.

A memorandum of all tool and machinery purchases and transfers is also required of all foremen on a "Tool and Machinery" report and all materials and supplies bought, or taken from stock, must be accounted for on "Material and Supplies" report. On jobs of magnitude a weekly report is required to keep a check on the work. On these jobs the foreman is usually competent to segregate work, or there is an inspector or engineer on the job, therefore a segregated report is required, thus saving an office segregation. We require a daily report from truck crews, not because of the fact that the magnitude of the work requires it, but because no report blank could be formulated which would show the elements required for a larger period than one day without being too complex to be kept in the field. We have the patrol system of maintenance on our main highways, and patrolmen are required to keep traffic reports for certain weeks.

A blank for the use of the Supervisor is the Tool and Machinery Receipt, and, while not properly speaking a part of the cost keeping system, a word of explanation may be proper on account of the close connection a check on tools has with the cost keeping. The receipt proper is the stub, and is kept by the Supervisor after being signed by the foreman. Upon returning the tools, or otherwise accounting for them, the foreman receives his release in the return receipt. In case tools are to be reloaned the Supervisor gives the man to receive the tools a reloan order in lieu of the tools, which he presents to the man possessing the tools as his authority.

The record books employed in the county consist of Overhead Account, containing the overhead expense and stock account; a Road Ledger, in which are charged road expenditures proper; a Bridge Record, for bridge expenditure, and an Engineering Account.

The Overhead Account is a bound book, with columns to show the following items: Date, Name, Warrant, Requisition No., Cause of Outlay, Tools and Machinery (subheads, No. Units, Unit Price, New Equipment, Maintenance Old), Supervision, Insurance, Miscellaneous.

The Stock Account should really be a separate book, but we keep it in the same book as overhead to save space. It comprises four columns, besides the date, name of claimant and voucher number, namely: Material or Supply, No. Units, Unit Cost and Total Cost. If it were carried in a separate book it would be more convenient to head groups of three columns with the kinds of material and supplies and place the other items as subheads. Whenever anything is taken from stock and charged to a particular road it is credited in red ink in the Stock Account. A column is also provided on the overhead page for items allowed but unaccounted by the reports or otherwise, which we hope in time will disappear.

The Road Ledger is divided into sheets for construction and maintenance, which are arranged together for each road and placed alphabetically in the book, according to the road name. The sheets are very similar and are divided the same, except that the top of the sheet is different. The top of the construction sheet shows Character of Country, History of Road, Bridges, and Right of Way, or Damages. The top of the maintenance sheet shows Brief History of Maintenance, History of Traffic. The colums and headings are as follows: Year, Month, Section, Township, Range, Nature of Work, Width (Subgrade, Surface), Wages Per Hour (Man, Team, Foreman), Work (No. Units, Unit), Cost (Unit, Total), Material and Supplies, Powder, Caps, Fuse, Lumber, Steel, Cement, Pipe and Blanks, all subheads Amt., [illegible], Total, and Grand Total, Fund and Remarks.

The Bridge Record, besides giving a description of bridge, shows construction on the left of the page and maintenance on the right, and is divided into Construction, Date, Name of Builder, Cost, Condition, Date, Nature of Repairs, Date, Cost, Repaired by, Remarks.

The Engineering Account shows the following items: Date, Name, Warrant No., Fund, and several blank columns to be headed with road name, and a Total Column.

# Concrete Road Construction During Freezing Temperatures

Early in October, 1917, it was decided to build a concrete road from the Marine Corps Camp at Quantico, Va., to the main highway to Washington. It was essential that this work be completed at the earliest possible date and as a consequence much of it was done during cold weather. The contractor for the construction of the marine camp carried out the road building under the direction of Maj. H. L. Roosevelt, post quartermaster of the camp. C. L. Brown, Senior Highway Engineer of the U. S. Bureau of Public Roads, was detailed to advise the quartermaster and to look after the engineering. The construction methods employed on the road are described by Mr. Brown in the July Public Roads, to which we are indebted for the matter that follows:

The work was started late in October and was completed March 13, 1918. During this time the thermometer sometimes reached zero and below, and during a large portion of the time the temperature was between zero and 32° F. It was necessary to adopt all possible measures to protect the concrete, both during its laying and curing.

The engineering features in connection with this were not unusual. The width was 18 ft., the thickness at the center 8¼ in., and at the sides 6 in. The road is reinforced with a wire mesh reinforcement weighing 28 lb. per 100 sq. ft. The concrete was mixed in the proportions of 1 part Portland cement, 1½ parts of fine aggregate, and 3 parts of coarse aggregate that consisted of washed and screened gravel. The grade and alignment followed the old roadway as nearly as possible and the few short, steep grades were reduced and some of the excavated material wasted to avoid heavy fills, which would undoubtedly settle later and cause bad cracks in the roadway.

**Plank Road for Traffic.**—Investigation proved that a good detour could be provided to the east of this road, which would allow the road to be entirely closed to public travel without serious inconvenience. The traffic incidental to the construction of the road was taken care of during the construction of the concrete road by the construction of a plank road along the side of the highway.

A camp was constructed for housing the laborers at a point midway between the two ends of the road. At this point were also constructed the stables for the live stock. Cement sheds were built at convenient places and filled with cement before the pavement reached these points. The storage of the cement was not sufficient and the necessary balance was hauled by truck and teams from Quantico during construction.

The usual method of construction of this kind of work was pursued until it became necessary to keep the concrete from freezing. The work was begun on the end of the road farthest from Quantico and continued toward Quantico. Later, work was started at Quantico and carried on simultaneously with the other work. For the first two weeks after starting the work was carried on night and day. It was then decided to abandon the night shift and work only the day shift.

About Nov. 23, 1917, it became necessary to adopt precautions against freezing. There was a great deal of delay due to the difficulty in obtaining from a commercial plant in Fredericksburg sand and gravel which they were unable to wash during the extreme cold weather.

**How Concrete Was Protected.**—The road was graded and the necessary drainage structures built as far in advance as possible of the concrete work. The sand and gravel were delivered during construction when they could be obtained, and were hauled in and dumped in rows on the sub-grade ahead of the mixture. Care was taken to deliver the materials in the right quantities for the concrete and avoid the hauling in of materials after the work was started.

When it was decided that the work must proceed regardless of the weather, attention was given to the question of protecting the concrete, and the following methods were adopted: The water was pumped into an elevated tank and from there flowed by gravity into a tubular boiler, where it was heated. In dumping the sand and gravel in rows on the subgrade, plain sheet iron pipe about 2 ft. in diameter was first laid on the subgrade and the material dumped on this. Fires were built in these pipes and in this way both the sand and gravel were heated to a proper temperature. These fires also served to keep the subgrade from freezing so that the concrete could be laid on an unfrozen subgrade. After the materials had been properly heated, mixed, and deposited, the finishers followed up the work immediately.

A mixer of 2-bag capacity was used to mix the concrete. This mixer had a 20-in. revolving iron tube 18 ft. long on the discharge end. This tube allowed a much drier mixture to be used and deposited the concrete in the best possible condition on the roadbed. The mixture was held in the mixer for one minute. The strike board was of a heavy plank cut to the crown of the road and the wearing edge shod with sheet iron.

**Finishing Roller Gives Good Results.**—At first a small wooden hand float was used to finish the concrete surface, but later a Macon roller was used with very good results. The roller was 6 ft. long and 10 in. in diameter. It was passed over the surface of the road from one edge to the other and back again; then advanced one-half its length and the rolling repeated. This operation was kept up until the roller reached the unscreeded concrete. After a short wait the rolling was repeated.

After the cold weather set in and it became necessary to protect the concrete the previous method was used as far as possible, but at times it was necessary to omit the second rolling and cover the concrete at once. The method of covering the concrete was as follows: Four-inch by 4-in. blocks 1 ft. long were placed on the side forms on each side of the road, and 2-in. by 12-in. planks, 20 ft. long, were stood on edge on these blocks and spiked to them. These planks spanned the pavement at as frequent intervals as necessary. On these planks were placed 2-in. by 6-in. planks lengthwise of the road. Over these in turn was spread a heavy canvas that covered the top and came over the edges and rested on the ground. Marsh hay was then spread over the canvas and banked against the sides, thus shutting out the cold air. The concrete then was covered until danger of damage by frost had passed, then the covering was moved ahead and used over again. Several thousand feet of this pavement were in service during the winter. It was covered with snow and ice and many auto trucks and light vehicles passed over it, but in the spring the surface showed no signs of frost action.

**Joints Spaced Irregularly.**—No attempt was made at the regular spacing of the joints; they were placed from 50 to 150 feet apart. The joint filler was three-eighths inch thick, made up of an asphaltic strip which extended entirely across the road. As used at first, the filler extended above the surface of the concrete a half inch, but later the concealed joint was used. This latter method allowed the surface to be finished continuously, making a smooth joint. Where the filler extended above the surface it was hard to get both sides on the same plane.

**Thawing Ground for Excavating.**—Until the ground became frozen it was a simple matter to do the excavating and grading. After the frost was in the ground it was found by experiment that a heavy wood fire built on the ground would remove the frost to a depth of 10 to 14 in. As there was plenty of wood to be had for the cutting this method was adopted. Logs were cut 10 ft. to 15 ft. long and a heavy fire was built over the full width of the subgrade. After the frost was out of the ground the fire was worked ahead and the excavation, carried down to the finished subgrade. The good supply of wood so close at hand was one great advantage of this method of softening up the ground.

There was one cut where the excavation was too deep to be taken out this way, so holes were drilled below the frost line and the ground loosened up with dynamite.

The steam jet method was tried but did not give satisfactory results.

The results show that it is possible to build a concrete pavement during freezing weather, but, if possible, it is better to postpone the work until warmer weather.

## North Carolina to Adopt Clock System of Numbering Highways

The clock system of numbering highways is to be adopted by the State Highway Commission of North Carolina. Under the plan the court-house at the county seat will be the center. The first road east of the north line in each county will be known as road No. 1; the second as road No. 2; the third as road No. 3, and so on around the county until the north line is reached. In case there is a branch road on any of these roads it could be numbered 1-A or 3-A, as the case may be.

With the roads thus numbered and the county markers up, every mile from the court-house it will be easy to indicate where any work is in progress. If there is any likelihood of a road being taken over as part of the state system, even if it is not at present included, that will be given a number also.

# Bituminous Surfaces on Macadam Roads in York County, Ontario*

For our own purposes we have divided bituminous surfaces into two classes: (a) Surface mats; (b) Wearing surfaces.

It must not be expected that surface mats will bring poor roads into good condition. They will, however, keep a good road from going to pieces.

Whether the road be gravel or waterbound macadam, it should be well drained, well built and properly crowned to shed the water easily, as water tends to deteriorate a bituminous mat. If, however, the road has become worn, it should be properly repaired before it receives surface treatment. If a gravel road, by adding gravel and loam; if a macadam, broken stone bound with bituminous binder.

Each strip of road requires different surface treatment, depending upon the traffic it has to carry, the character of the material used in its construction and its previous treatment. So you will readily see that methods described here are only general, and must be modified to suit local conditions.

**Surface Mats.**—In a general way our method is as follows:

First, sweep the road with a power broom and have a man with a stable broom follow to clean off any incrustation or clean out depressions that the power broom might miss.

If it is the first treatment the road is to receive we use a light material, thus securing better penetration, and your succeeding treatments appear to revive the bituminous substance to the depth of the first penetration. Some have said penetration is not possible or necessary, but we have found it always possible and highly desirable.

In mat surface treatment we only cover one-half of the road at one time. This makes it possible for cautious and careful teams and motor drivers to keep out of the bitumen. When possible we keep the traffic off the material for several hours, and before the traffic is allowed on the road we sprinkle the treated surface with a sharp sand. Do not sweep back the dust you cleaned from the road; it absorbs the bitumen, whereas the sharp sand and pea gravel allows it to penetrate while keeping the traffic out of the bitumen.

The first application will require about $\frac{1}{3}$ gal. of bitumen per square yard, and it requires to build up the mat about 1 cu. yd. of sand for each 250 sq. yd. of road.

By having a man follow the oil wagon with a stable broom to spread out possible puddles of the material, and by the proper use of sand and pea gravel, you can cut your use of bitumen so as to more than pay for the sand. Last year we cut down both the quantity of sand and the cost of applying by equipping a couple of hoosier wagons with boxes and rollers underneath to spread the sand. We find, however, that whether you use spreaders or put the sand on with shovels a man must go over the road the next day to respread the sand where the bitumen has been bleeding.

The second and succeeding years clean the road in a similar manner, but use a heavier material, which may be applied in less quantity.

You will usually find that the quantity of material required depends on the kind of spring. If the snow goes early and spring is slow in coming, your bituminous surface will get all chopped up and will finally be washed away.

We always apply our bituminous material hot. It spreads more evenly and penetrates better, and, of course, if you want penetration, do not apply when the roads are wet. You will have noticed this, however, that your clean-swept, firm roads are dry when the other roads are wet. These successive applications will build up a bituminous carpet that will take both heavy and constant traffic, so that the stone of your road does not wear down, and is, after 5 years' use, apparently as good as when first placed.

These carpets or surface mats serve several distinct purposes. They prevent attrition of the road; the lighter dust that blows over is held. They form an elastic cushion for the traffic and prevent the removal of the binder from the gravel or stone.

**Bituminous Wearing Surfaces.**—While we have many miles of surface treated roads that were economical to build and cheap to maintain, there has been a disposition to experiment with a type of road that would not require annual surface treatment. We thought at one time we could keep our roads up to standard by surface treating every other year. This we found was very poor economy, so we took up the question of a semi-permanent bituminous surface.

Our first venture was with a bituminous macadam penetration method, and each year since 1914 we have added a limited mileage of this type of pavement to the system. The base is built as for waterbound macadam, but with less crown. Then $1\frac{1}{4}$-in. stone, varying in depth from $2\frac{1}{2}$ in. to $3\frac{1}{2}$ in., is carefully spread, and into this hot bitumen is sprayed at the rate of $1\frac{3}{4}$ gal. per square yard. This is then sprinkled with $\frac{1}{2}$-in. stone chips and the road consolidated. As a seal coat this surface is then sprayed with a lighter bitumen and again sprinkled with stone chips.

The wearing surface thus presented is good for some 4 or 5 years, when it will have to be again surface treated with the light bitumen and fine stone.

Four years of testing surfaces of this type leads us to believe that under certain conditions this surface is most satisfactory, but if the traffic is very heavy and intense a higher type of road may be required, and perhaps we have this in the bituminous macadam mixed method, which was used in 1917 in reconstructing Dundas St., now known as Eaton Road. This road was built in 1909, having in mind, as I take it, the preponderance of iron-tired, horse-drawn vehicles, and gave good service until the traffic changed and the rubber-tired, self-propelled vehicles became almost the only traffic. For this new condition the bituminous surface mixed method was adopted.

In review our experience in York has been as follows: We commenced by sprinkling with light bitumen; we then went to heavy bitumen; to penetration methods; to mixed methods, and let me close by saying I believe that for 75 per cent of our county roads we are going to use waterbound macadam or gravel roads with heavy surface treatments.

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**Granite Paving Block Production in 1917.**—Granite paving block production in 1917 was 13 per cent below that of the previous year, according to statistics collected by the U. S. Geological Survey. In 1917, 39,987,000 paving blocks were produced, while in 1916 the production amounted to 45,961,000 blocks. However, the average price in 1916 was $50.73 per 1,000 as compared with $57.63 in 1917.

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*From a paper by E. A. James, [illegible] York Highway Commissioners, presented at the conference of Ontario Road Superintendents.

## Outagamie County, Wisconsin, Highway Contract Assures Contractor of Definite Profit

A new form of contract is being employed by Outagamie County, Wisconsin, for the construction of a concrete highway. The contract was drawn up by Mr. Walter J. Driscoll, Assistant Commissioner of Highways for the county. Under it the contractor is assured of a conservative definite profit per mile, with a possible chance of reward, if he executes his work systematically and economically. The county, on the other hand, is amply protected and may profit by the construction of the road at a minimum cost.

During the past three seasons the county has been constructing about 20 miles of concrete roads yearly. The results secured in the execution of these contracts have been in the main satisfactory. However, the few experiences with inexperienced contractors have forced the commissioners to the conclusion that a way must be found wherein they could exercise a choice in the selection of contractors who were to handle their future road work. The few experiences in awarding road contracts to the low bidder who is inexperienced and who did not possess sufficient capital to execute the work systematically and in the minimum length of time have proved so unsatisfactory that it was decided to enter into a new form of contract for the construction of the Seymour South highway with one of the most successful and reliable contractors.

This contract consists of a plain concrete highway, 9 ft. in width, and about 4 miles in length. The contractor is to furnish all machinery and equipment, and is to give his constant personal supervision over the work, for the fixed sum of $900 per mile.

The county furnishes the contractor with all the materials f. o. b. the nearest railroad station.

The labor is to be hired and paid for by the contractor, but twice monthly he is to be reimbursed by the county for all money expended by him for labor. The county's daily inspector, who is constantly on the job, will act as timekeeper of the labor employed by the contractor, and will render daily reports covering same to the office of the county highway commissioner.

Attached and forming a part of this agreement is a preliminary estimate prepared by the county highway commissioner as to the labor cost of the contract based upon the county highway commissioner's estimate of the labor cost per mile. The contractor is to receive a bonus for any saving made by his keeping the total labor per mile cost under the estimate. Likewise he is to assume a portion of the additional cost to the county in case the expenditure for labor exceeds the estimate.

A sliding scale of percentage, covering both the penalty and bonus clauses, has been arranged. The aim in so doing was to increase the percentage of bonus offered, based upon the amount saved. The scale of percentage also is increased as the additional cost to the county over and above the estimate becomes greater.

On this particular contract the county's estimate for the total labor cost was $4,087.20 per mile. The scale of bonus was as follows:

If the contractor completes this contract for total labor cost per mile below the estimate, and ranging between the sums of $3,998.40 and $4,298.40, which is the estimated cost, he is to receive a bonus of 20 per cent of the saving effected by the county.

If the total labor cost per mile ranges between the sum of $3,700 and $3,998.40, he is to receive a bonus of 40 per cent of the saving effected by the county.

If the total labor cost per mile is below the sum of $3,700, he is to receive a bonus of 50 per cent of the saving effected by the county.

The penalty clauses work out in the following manner:

If the final complete labor cost per mile exceeds the sum of $4,298.40, which is the county's estimate, and ranges between that amount and the sum of $4,598.40, the contractor is to assume 20 per cent of the additional cost to the county over and above the estimate.

If the final complete labor cost per mile ranges between the sum of $4,598.40 and $4,896.80, he is to assume 40 per cent of the additional cost to the county.

If the final complete labor cost per mile exceeds the estimate and totals any amount over the sum of $4,896.80, he is to assume 50 per cent of the additional cost to the county.

The county highway commissioner also reserves the right to set the maximum wage that the contractor may pay for labor and teams, and still further reserves the right to discharge any or all workmen whom the contractor may have employed, who prove unfit or incompetent.

## Home Made Scraper for Spring Clean Up of Streets

A home-made horse-drawn scraper is employed by the city of Rochester, Minn., in the early spring for removing the winter's accumulation of dirt from the streets. The arrangement was described by Mr. J. C. Utton, City Engineer, in a paper presented before the Affiliated Engineering Societies of Minnesota. The scraper is made of a 2-in. oak plank, 7 ft. long and 14 in. high, with two side pieces or runners, 10 in. by 14 in. by 2 in., fastened together by means of straps and iron bolts. A piece of flat iron ¼ in. x 6 in. extending below the plank 1½ in. is bolted to the front of the plank. Handles are bolted back of the scraper and a rope fastened to the plank, with which the operator pulls back the scraper into position after dumping. The iron blade scrapes along the pavement, and immediately the handles are let go, the scraper automatically dumps itself. After scraping the dirt in rows, the scraper is used for piling it up, after which the pickup wagons cart it away. With one team and driver and man for the scraper, two pickup teams and one shoveler, approximately 2,000 sq. yd. are cleaned per hour, at a cost of 13 ct. per 100

## Underdrainage of City Pavements

In connection with its repaving program the city of Cleveland, O., of which Fred R. Williams is Paving Engineer, has adopted standards for the underdrainage of the streets. The standard drains are 4-in. vitrified pipe laid behind and 6 in. below the bottoms of the curbs on both sides of the street for the entire length of the pavement. The trench or space behind the curb is filled with cinders for at least 1 ft. above the top of the pipe. The drains are designed to remove water to an elevation at least 2 ft. below the base of the pavement and they discharge into catch-basin connections or into sewer manholes. Additional drains are provided in streets where soil conditions are known to be unfavorable. When special installations are required, the necessary modifications of the standard type are made accordingly.

# Cracking of Concrete Roads and Its Prevention by Reinforcing with Steel

The most serious defect in a plain concrete road slab is its tendency to crack. An interesting discussion of the underlying causes of this cracking, together with a description of the methods used to prevent or to control this tendency, is given by Mr. W. B. Sawyer, Jr., in a recent issue of Western Engineering, to which we are indebted for the matter in this article.

### Transverse Cracks.

**Expansion of Concrete Because of Change of Temperature.**—The coefficient of expansion of concrete is 0.0000055 per degree F. For every degree F. rise in temperature concrete will expand 0.0000055 times its length. If the concrete slab were resting on a frictionless plane this movement would cause no stresses in the slab, but unfortunately we do not have any such ideal conditions. There is a definite amount of friction between the surface of the sub-base and the surface of the concrete slab above it. This varies with the kind of base and the degree of roughness of surface. The friction between the two surfaces resists any movement. When movement does occur, the resistance of friction causes tensile stresses in the concrete. When these stresses become greater then the tensile strength of the concrete, cracks occur.

**Change in Moisture Content.**—Another cause of cracking, and probably the most important one, is change in the moisture content of the concrete. When concrete is hardened under water or under moist conditions it expands slightly. The expansion varies somewhat with different mixtures, and according to tests is from 0.02 to 0.05 per cent of the length. When concrete is hardened in air and the moisture is evaporated it will contract. The shrinkage may be as much as 0.08 per cent of its length. To counteract this contraction by an equal amount of expansion, because of a change in temperature, a rise of 145° F. would have to take place. This is illustrated by the recent statement of the United States Bureau of Standards that concrete roads expand in winter and contract in summer because of increase or decrease in the moisture content. This shrinkage, caused by the drying of the concrete, occurs when the concrete is not fully hardened and its tensile strength is low, probably not over 50 lb. per square inch; therefore the stresses developed by only a slight movement of the slab at this time will produce cracks. These are the characteristic transverse cracks which occur in plain concrete pavement at intervals of 25 to 35 ft.

### Causes of Longitudinal Cracks.

**Non-Uniform Bearing on Sub-base.**—This may be the result of unequal settlement of fill or similar causes. The road slab is not designed to carry its load as an ordinary floor slab or beam. If the slab is left unsupported, either at the center or sides, the load imposed will often cause longitudinal cracks.

**Expansion or Contraction of Sub-base Because of a Change in Moisture Content.**—The most troublesome sub-base in this regard is the adobe of central and southern California. This soil absorbs water, causing considerable expansion, then upon drying shrinkage takes place and opens the familiar adobe cracks. The shrinkage stresses are usually great enough to cause cracks in plain concrete resting upon the sub-base. The supporting power of the sub base is the important element in the consideration of longitudinal cracks. Even with the most careful construction methods it is hard to get a uniform and homogeneous sub-base that is dependable as far as supporting power is concerned.

Consideration of the various causes producing cracks in unreinforced concrete shows that the most important and most frequent are, first, shrinkage of concrete when hardening, causing transverse cracks, and, second, insufficient support of sub-base, causing longitudinal cracks. By increasing the tensile strength of the concrete slab it has been found that these cracks can be either entirely eliminated or else so controlled that they are no longer a serious defect. This increased tensile strength is gained by the addition of steel reinforcement.

### Placing Reinforcing Steel.

**Prevention of Longitudinal Cracks.**—Two systems for placing the reinforcement are now being used in California with success. The first system is for eliminating the longitudinal cracks. The steel is in the form of wire fabric in strips about 5 ft. in width and in length equal to the width of the road to be paved. The main or longitudinal wires are placed at right angles to the center line of the road. The weight of fabric varies from 22 to 35 lb. per 100 sq. ft., the average being about 31 lb. The method used in placing the fabric is simple and has been found not to hinder or retard the mixing and placing of the concrete. The fabric is placed on the job in proper lengths. These strips are placed one at a time upon the prepared sub-base directly behind the mixer, between it and the already finished pavement. The concrete is then poured in the usual manner and allowed to flow over the mesh. After the shovelmen have properly distributed the wet concrete to the required thickness a small hook is used to raise the wires to the center of the slab. Care is taken to make sure that the steel is embedded approximately in the center, as, of course, it would be useless if left resting upon the sub-base. Two extra men per gang are needed for handling and placing the fabric. This method of reinforcing has proved satisfactory. It eliminates the longitudinal cracks.

This system of reinforcing has been used extensively by the State Highway Commission of California. They have found it especially useful in preventing longitudinal cracks in pavement that is laid over adobe sub-base.

**Controlling Transverse Cracks.**—The second system for placing the mesh is designed to control the transverse cracks in the concrete and to increase the distance between them. Some highway engineers control these transverse cracks by placing contraction joints every 25 to 35 ft. Such joints are the weakest feature of the concrete pavement. No matter what type of joint is used, they must be given frequent and careful attention to prevent rapid deterioration of the adjacent pavement. They should therefore be separated as far as possible. This is accomplished by placing the main or longitudinal wires of the reinforcing material parallel to the center line of the road. The method employed is similar to the first system described, with this difference—the mesh is not cut into strips, but is placed on the job in rolls several hundred feet long and of the proper width. These rolls are placed directly behind the mixer. They are unrolled as the mixer is moved forward, thus making the longitudinal reinforcement continuous. The concrete is poured and the steel is raised by hooks to the center of the slab as in the other system. Two or three rolls are used, depending on the width of the road. By giving a small lap on each width, reinforcement at right angles to the direction of the road is obtained. This prevents the longitudinal as well as the transverse cracks. The advantages of this system are obvious. It eliminates many expansion joints, prevents longitudinal cracks, and is somewhat cheaper than the first system. This system has been used with great success in Tulare County under the direction of Byron Lovelace, County Highway Engineer. One stretch of road in particular is worthy of mention. In building the main highway near Exeter a great deal of adobe soil was found in the sub-base. It was therefore decided to reinforce the entire section. The system described above was used. Although the contraction joints were placed about 600 ft. apart, not a single crack can be found in the mile of highway. Experience with this system of reinforcing has shown that the distance between contraction joints can be made as much as 300 ft. with safety, thus allowing joints to be placed at midday and at the end of a day's run, where the daily run is about 600 lin. ft.

**Cost of Reinforcement.**—The cost of the reinforcement varies, of course, with the situation of the work and the weight of reinforcement. Basing costs on contract work in central California and with steel weighing about 30 lb. per 100 sq. ft. of mesh, the cost of the material delivered is approximately $1.65 per 100 sq. ft. Adding to this $0.10 per 100 sq. ft. for hauling and placing gives a total cost of $1.75 per 100 sq. ft. for reinforcement in place. The cost per mile for reinforcing a road 15 ft. wide is $1,386. The annual interest charge, therefore, per mile is about $70. This annual cost is much less than the cost of maintenance and repair because of the cracks in plain concrete pavement, and is also largely offset by the elimination of the first cost of nearly all of the contraction joints. A light slab properly reinforced will outlast a heavier slab without reinforcement. Although the slab should be heavy enough to carry the traffic safely, in cases where first cost is of primary importance, better results can be obtained by using a relatively thin slab with proper reinforcement than a slab an inch thicker without it. Under such conditions the first cost is approximately the same in both cases.

The use of steel reinforcement in concrete pavement is theoretically correct, as it furnishes tensile strength to the concrete and enables it to resist stresses that would otherwise produce cracks and which, even with an asphalt top, either reduce the life of the pavement or else increase the expense for repairs. Also it furnishes additional strength to resist forces caused by adverse conditions in the sub-base. In actual practice, not only in California, but in practically all of the other states both East and West, it has proved its efficiency. Its use has been demonstrated to be economically sound and in the interest of true economy.

**Asphalt Imports Restricted.**—Asphalt has been placed on the restricted import list by the War Board. Imports for 1918 will be limited to a total quantity of 30,000 tons from Venezuela and 32,000 from the Island of Trinidad. All outstanding licenses for the importation of asphalt are revoked as to shipments made after June 15, 1918. Allocation of the amounts permitted to be imported, regulation of the price and other details will be arranged after conference with the War Industries Board.

# Notes on Gravel Road Construction*

By H. E. PHELPS,

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In the extensive use of gravel in Colorado, defects in construction and maintenance have often resulted in an unsatisfactory road and have given rise to a demand for a more permanent surface. On the main highways this demand is justifiable, and a more permanent road surface must be used. Where the traffic is not in excess of 500 vehicles per day, a gravel road carefully constructed and maintained is the most economical and satisfactory possible.

Colorado has thousands of miles of roads needing improvement, and is neither a rich nor densely populated state. It is all the more necessary, then, that not a dollar of whatever money is available be wasted on unnecessarily expensive roads, and that intelligent thought be given to the problem of providing the best possible road for the least possible amount of money. It is believed that this result can be secured in many parts of Colorado by building and maintaining gravel roads according to the best practice, as outlined in the following paragraphs:

The first essential for any kind of surfacing is a well-graded and drained earth road, with no grades in excess of 6 or 7 per cent if possible. The most vital factor in the construction of roads is proper drainage, for faulty or insufficient drainage is responsible for many of the repairs required on old gravel roads.

**Gravel.**—A good road-building gravel should be composed of hard and tough stones, the proportions of the different sizes being such that the voids will be a minimum, and should contain enough binding material to cement the whole mass together. For best practice, specifications should require 67 to 75 per cent of pebbles that will pass the 1½-in. screen and be retained on the ⅛-in. screen, with no pebbles longer than 1½ or 2 in. This often requires crushing larger stones and screening out excessive amounts of binder, refinements frequently neglected, to the detriment of the resulting road.

After the road has been graded and shoulders formed, the gravel should be applied. Two courses should be used for heavy traffic, and no course should exceed 6 in. deep of loose measure. The gravel after dumping upon the prepared subgrade should be spread to uniform thickness.

**Spreading, Harrowing and Rolling.**—Usually the gravel should be placed first on the end of the road nearest the supply, so that the teams will aid in packing. The gravel, after spreading, should be frequently harrowed, and if as much as 100 cu. yd. of gravel are hauled to the road each day one team should be continuously employed on the harrow. The importance of thorough harrowing can scarcely be overestimated, but it is nevertheless frequently omitted.

The gravel should then be well wetted, either by rains or in Colorado by artificial means. Water can be hauled in carts or pumped through a temporary pipe line from some irrigation ditch or well. For good results it is essential that the gravel be harrowed, that it be wetted, and that it be then rolled. A power roller is best. The grader or drag will probably have to be used at times to preserve the crown, and the harrow should be kept running until the teeth refuse to penetrate the surface. Spreading the gravel dry to a thickness of a foot and leaving it for travel to compact, as is quite commonly done, will never give a good gravel road, especially in a dry climate like Colorado's, and is bad practice in any locality.

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*From the Journal of Engineering, University of Colorado.

**Maintenance of Gravel Roads.**—To maintain a gravel road in a satisfactory condition it must have constant attention. With proper care in the early spring, followed by continued dragging after rains and the repair of little defects and holes, the surface can be maintained in a satisfactory condition and early resurfacing or reconstruction forestalled at a consequent saving in cost which will more than compensate the added cost of maintenance. The tendency in Colorado is to largely neglect maintenance, on the theory that dragging a gravel road does no good, and that the patrol or continuous system of maintenance is too expensive. Dragging is often delayed until the road has dried after a rain, and then is not beneficial. A gravel road should be dragged during the first few months after completion following every rain, and afterward only after prolonged wet spells have softened the surface. Few attempts have been made to apply continuous maintenance, or to compute the cost of frequent reconstructions without continuous maintenance, so that the argument regarding the expense of such maintenance rests upon scanty facts.

Ten yards of gravel should be placed in neat piles every ½ mile along the road, to be used in patching holes. This work should be done while the road is wet. The hole should be first cleaned out, and then filled level full, but no more, with well-compacted gravel, wetted down before being tamped into place. This patching should be as continuous as possible, and in dry weather may require sprinkling the road before patching it.

In Colorado the year 1917 had a precipitation only 65 per cent of normal, being less than 10 in. in many localities. The spring, however, was wet, and lack of proper dragging left many gravel roads with ruts due to traffic. During the dry summer all the dust and loose binder on the surface were blown away by the wind, leaving a mosaic-like surface of projecting pebbles. These pebbles were quickly displaced by traffic, with the result that holes and ruts speedily formed in the surface. Many gravel roads were soon in such condition that automobile traffic avoided them in favor of unimproved dirt roads.

Such extreme conditions certainly call for the most careful attention in construction and maintenance, in order that the road may always be in the best possible condition and as capable as may be of resisting the disintegrating effects of heavy traffic during a prolonged dry spell. It must be confessed, however, that under extreme conditions of traffic and dryness something additional must be done to prevent rapid deterioration of well-built gravel roads and the practical destruction in a short time of poorly constructed ones. This additional work will either have to be artificial sprinkling or bituminous surfacing, or else some other form of construction will have to be employed.

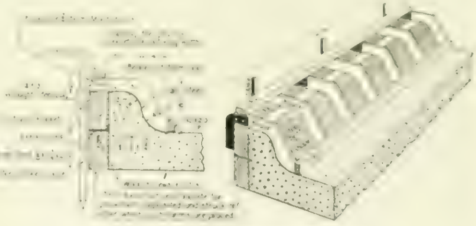
Frequent sprinkling of the surface of a gravel road in dry weather is probably too expensive for general use, even if done by motor-driven sprinklers. It would be advisable, however, to consider this method in some cases, as frequently a few days of dry, windy weather will result in so much damage from heavy traffic that a gravel road will need resurfacing, a more expensive procedure than the sprinkling required to carry the road intact over this period.

Bituminous surfacing is being tried out on the Lincoln Highway north of Denver, and has been the chief reliance in maintaining gravel roads in several states, notably Maine. An instance recently reported from that state shows that a gravel road 16 ft. wide can be maintained in good condition under a traffic of over 1,200 vehicles per day by an annual treatment of 4 10 gal. per square yard of Tarvia B, at a cost of approximately $850 per mile per year. This figure includes the wages of a patrolman, who works continually on the road except in the winter, and cares for from 6 to 8 miles of road. A patrolman is also provided on less heavily traveled roads that are maintained by patching and dragging. This amounts to $250 per mile per year, which may be taken as the minimum that should be provided for the maintenance of any gravel road.

## Form for Integral Curb Construction

The advantages of integral curb construction are becoming widely recognized. A form for this type of curb and suggestions for its use are given in a recent issue of the Concrete Highway Magazine, from which the matter in this note is taken.

In building this curb some contractors have placed their forms and filled them at the time of the placing of the concrete for the pavement proper. The difficulty with such a procedure is that the water removed by rolling and with the belt finds its way to the gutter line and must be removed by brooming. However, even with the most painstaking efforts some laitance will remain along the gutter and will subsequently check, resulting in a rough flow line.



Details of Curb Section and Form.

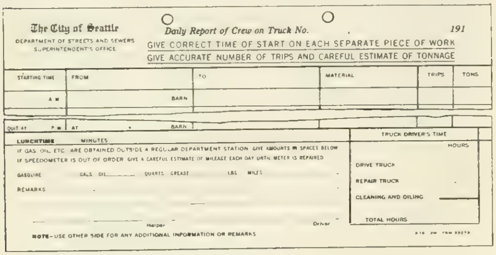
To avoid such a condition many contractors are following the plan of placing and finishing with the roller and first belt the pavement proper, then placing their curb forms and constructing the curb. This is the method that is recommended, because of the facility in finishing, in removing the excess water, and in avoiding any laitance effect.

In order that this procedure can be followed it is necessary that the retaining form for the curb be built up in two sections, as shown on the drawing. The first section serves the purpose as a side form and permits the roller and belt to be operated over it. After the first belting, the second section of this form is placed and the integral curb mold put in position.

The only objectionable feature to such a method is that it necessitates wheeling sufficient concrete for the curbs from the mixer to where the curb forms are in place, but this additional cost is offset by the increased speed and facility which can be attained on curb finishing work.

# Cost Keeping System of Seattle Street and Sewer Department for Motor Truck Operation

A very complete cost keeping system is employed by the Department of Streets and Sewers of Seattle, Wash., for recording the operation of its motor trucks and automobiles. The cost keeping was started in 1913, and the system has been developed to suit the needs of the department. The accurate and complete cost records obtained by the system, and the active co-operation of drivers, mechanics and others interested, have made it possible to reduce the daily operating costs of the trucks from $12 to $15 in 1913 to an average of $7.46 in 1916 and $8.81 in 1917. At the present time the truck drivers are being paid $125 per month and the cost of material has advanced from 100 per cent to 300 per cent. As a consequence the truck operation is averaging between $10 and $11 per day. These figures include all labor, material and wages of the drivers.


The City of Seattle
DEPARTMENT OF STREETS AND SEWERS
SUPERINTENDENT'S OFFICE

*Daily Report of Crew on Truck No.* 191

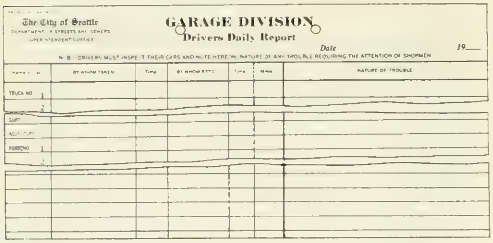
GIVE CORRECT TIME OF START ON EACH SEPARATE PIECE OF WORK
GIVE ACCURATE NUMBER OF TRIPS AND CAREFUL ESTIMATE OF TONNAGE

| STARTING TIME | FROM | TO | MATERIAL | TRIPS | TONS |
|---|---|---|---|---|---|
| A M | BARN | | | | |
| QUIT AT P M | AT BARN | | | | |

LUNCHTIME MINUTES
IF GAS, OIL, ETC. ARE OBTAINED OUTSIDE A REGULAR DEPARTMENT STATION GIVE AMOUNTS IN SPACES BELOW
IF SPEEDOMETER IS OUT OF ORDER GIVE A CAREFUL ESTIMATE OF MILEAGE EACH DAY UNTIL METER IS REPAIRED
GASOLINE GALS. OIL QUARTS GREASE LBS. MILES
REMARKS
Helper
Driver

TRUCK DRIVER'S TIME
HOURS
DRIVE TRUCK
REPAIR TRUCK
CLEANING AND OILING
TOTAL HOURS

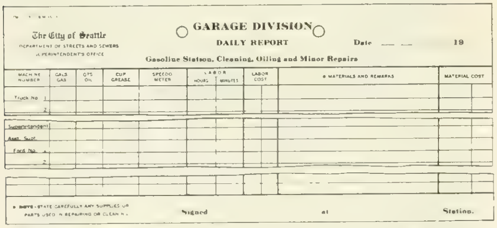
NOTE—USE OTHER SIDE FOR ANY ADDITIONAL INFORMATION OR REMARKS


The City of Seattle
DEPARTMENT OF STREETS AND SEWERS
SUPERINTENDENT'S OFFICE

GARAGE DIVISION
Drivers Daily Report
*Date* 19

N. B. DRIVERS MUST INSPECT THEIR CARS AND NOTE HEREON NATURE OF ANY TROUBLE REQUIRING THE ATTENTION OF SHOPMEN

| Name [illegible] | BY WHOM TAKEN | Time | BY WHOM RET'D | Time | Miles | NATURE OF TROUBLE |
|---|---|---|---|---|---|---|
| TRUCK NO 1 | | | | | | |
| 2 | | | | | | |
| SUPT | | | | | | |
| ASST SUPT | | | | | | |
| FORD NO 1 | | | | | | |
| 2 | | | | | | |


The City of Seattle
DEPARTMENT OF STREETS AND SEWERS
SUPERINTENDENT'S OFFICE

GARAGE DIVISION
DAILY REPORT
Date 19
Gasoline Station, Cleaning, Oiling and Minor Repairs

| MACHINE NUMBER | GALS GAS | QTS OIL | CUP GREASE | SPEEDO METER | LABOR HOURS | LABOR MINUTES | LABOR COST | * MATERIALS AND REMARKS | MATERIAL COST |
|---|---|---|---|---|---|---|---|---|---|
| Truck No 1 | | | | | | | | | |
| 2 | | | | | | | | | |
| Superintendent | | | | | | | | | |
| Asst. Supt. | | | | | | | | | |
| Ford No. 1 | | | | | | | | | |
| 2 | | | | | | | | | |

* NOTE—STATE CAREFULLY ANY SUPPLIES OR PARTS USED IN REPAIRING OR CLEANING
Signed at Station.

Top Form: Fig. 1—Daily Report of Truck Crew. Middle: Fig. 2—Daily Report for Driver. Bottom: Fig. 3—Report Form for Gas and Oil.
Actual Sizes of Forms: (Fig. 1) 8½x8½ in., (Fig. 2) 10x14 in., (Fig. 3) 10x14 in.

Average figures covering the operation of 7 trucks in 1916 and 9 trucks in 1917 follow:

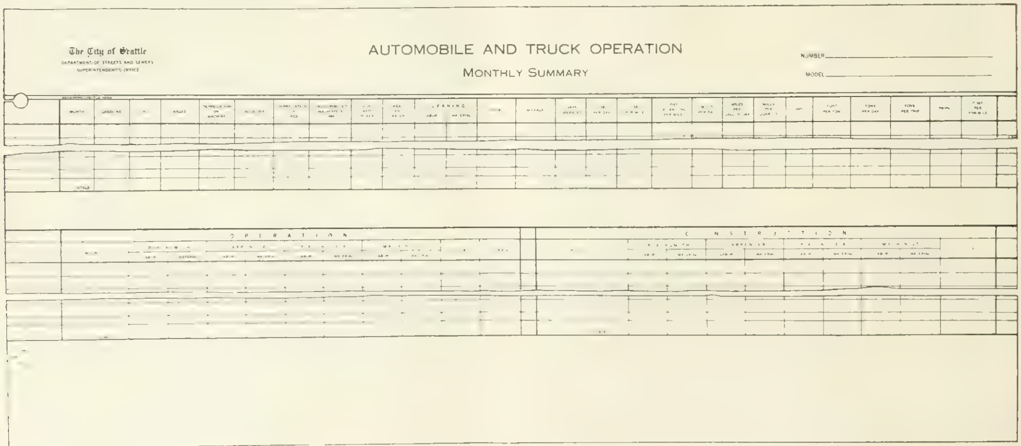
| | 1916. | 1917. |
|---|---|---|
| Miles per day | 32.7 | 33.3 |
| Miles per gal gas | 3.71 | 3.21 |
| Miles per quart oil | 21.1 | 16.93 |
| Tons per trip | 2.69 | 3.08 |
| Cost per ton | $0.367 | $0.388 |
| Cost per mile | 0.223 | 0.264 |
| Cost gas and oil per mile | 0.029 | 0.059 |

Wages of truck drivers in 1916, $90 per month; in 1917, $100 to May 1 and $110 from then on. Drivers worked 8 hours per day.

The forms used for the daily report of truck crews is shown in Fig. 1. Each trip is recorded on this form, together with time and material, trips made and tonnage, from which ton miles are worked up once each month, thus giving the department a direct line on the cost of operation.

Figure 2 shows the form for the daily reports of the drivers of the trucks and the automobiles. On this is recorded at the end of each day any trouble which should be taken care of. The report is turned over immediately to the head machinist who gives the car the necessary attention, often necessitating an hour or two overtime in the evening, in order that the cars may be ready for work the following day, thus reducing to a minimum the time that the cars are standing idle. This form is made out with carbon duplicate, the latter being retained in the machine shop, and the original sent to the main office.

Gasoline and oil supplies for the trucks and automobiles are obtained only from the man in charge of the garage division. The form used by him is shown in Fig. 3. All gas and oils are immediately recorded on this sheet, together with the speedometer reading at the time of filling. All minor repairs and adjustments are done in this department. This di-


The City of Seattle
DEPARTMENT OF STREETS AND SEWERS
SUPERINTENDENT'S OFFICE

AUTOMOBILE AND TRUCK OPERATION
MONTHLY SUMMARY

NUMBER
MODEL

TOTALS

OPERATION
CONSTRUCTION

Fig. 4—Form for Monthly Summary of Automobile and Truck Operation by Department of Streets and Sewers of Seattle.
Actual Size of Form Is 25x17 in.

vision is handled by two men, in two shifts of 8 hours each. The monthly summary of truck and automobile operation is recorded on the form shown as Fig. 4. The information from this summary, in a condensed form, is sent to the City Council each month. A table giving comparative costs for each truck for the month is made up from the summary and posted in the station from which the trucks operate.

Figure 5 shows the form for keeping records of tires. One of these is used for each tire. By means of these records a complete history is given of every tire in use by the department. They are worked up once each month and the total depreciation of the four tires taken from the four cards and transferred to the form shown as Fig. 6.

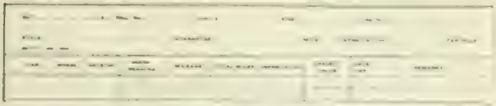
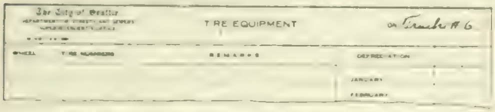


Fig. 5—Form for Keeping Record of Tires.
[illegible]

The system includes several other report forms. Two of them cover major repairs, another covers work in the machine shop. Forms for permanent records of each truck also are used. The form showing the repair cost of each truck is made up from the information on the machine shop forms and on the forms used in the paint, blacksmith and carpenter shop. The permanent operating record of each truck is compiled from the information obtained from the forms shown as Figs. 1 and 3.



TIRE EQUIPMENT on Truck #6

REMARKS

DEPRECIATION

JANUARY

FEBRUARY

Fig. 6—Form for Recording Depreciation of Tires.
[illegible]

The system was devised by Mr. M. S. Meengs, Chief Clerk of the Street and Sewer Department, of which Mr. Charles R. Case is Superintendent.

## Cost of Street Flushing at Rochester, Minn.

The main street cleaning apparatus of Rochester, Minn., a city of about 10,000 population, consists of a horse-drawn, power flusher, Studebaker model, of 700-gal. capacity. The flusher is used once a week on all residence streets, and three times a week in the business district. During the season April 1 to Nov. 1, 1917, a total of 9,557,700 sq. yd. were flushed. The total cost of operation, according to a paper presented before the Affiliated Engineering Societies by J. C. Utton, City Engineer, was 23.9 ct. per 1,000 sq. yd. per season. This figure includes cost of gasoline, oil, labor, repairs and water at 7 ct. per 100 cu. ft. The unit costs were as follows:

| | [illegible] |
|---|---|
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |

## The Necessity of Engineering Supervision in Construction and Maintenance of Earth Roads*

By H. ROSS MACKENZIE.

[illegible]

The absolute necessity for engineer supervision in the construction of so-called "permanent" highways and large bridges is quite apparent to the average layman, but an erroneous idea is prevalent in Canada and particularly in Western Canada, to the effect that no special training or experience is required in order to supervise the construction of earth roads. This idea is one of the greatest obstacles in the way of securing better transportation facilities in the prairie provinces, and in the following paper the writer shall endeavor to present a few of the many arguments in support of the contention that the construction of earth roads requires the supervision of competent engineers:

The term "construction" as used in the heading of this article, refers not only to the grading of a road, but also to the location of required diversions, and to the installation or erection of the culverts and small bridges necessary to provide proper drainage facilities; and in view of the fact that Saskatchewan has not a single mile of "permanent" highway constructed in its rural area, this article applies generally to all road construction work in the province.

Road building is divided into two parts, the theoretical and the practical, the one pertaining to the engineer, the other to the foreman or contractor. The engineer's duty is to design the road, having regard to cross-sections, gradients, alignment and drainage, whereas the duty of the foreman or contractor involves the direction of labor in an efficient manner.

We are still largely dominated in Canada by the belief that any ordinary capable man, possessing the necessary energy and ambition can do the work which should be done by a trained scientist. This belief is the direct result of rapid immigration to a country whose resources are abundant and where the absence of competition has enabled men lacking in scientific education to succeed in spite of crude and wasteful methods. This stage in the development of the prairie provinces is now passing; specialists in the various trades and professions are coming into prominence, and the public is beginning to realize that in road building, as in other construction work, the skill of the specialist is required. This awakening is largely due to the fact that although considerable sums are annually expended on road improvements, the ratepayers of the various municipalities find that the roads leading to their market centers are still in unsatisfactory condition.

The economic necessity of properly supervising the expenditure of funds for road construction, is well emphasized in a paper written by Adolph Edwards, who has had 15 years' experience in road improvement work in Florida. Mr. Edwards states that of the $300,000,000 spent on road improvement work in the United States in 1916, one-third was wasted. He added that "this condition is the fault of the taxpayers primarily; they have not called for business-like administration and they have not received it.

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*[illegible]

The pressing road problem of the country today is not so much to provide money for our highways and byways as it is to awaken the average taxpayer to a knowledge of the business side of the work for which he is contributing so liberally; that he may enlist the help of the ablest business men and the services of competent engineers in carrying it on. There is no question as to the correctness of the statement, the expenditure of road funds and the direction of road work by men of special training for the work is very often the exception rather the rule. Many a county has spent enough money to have good roads, but have poor roads, because that money has not been judiciously expended. It is not a question of dishonesty in most cases, but of incompetency.

The startling statement made by Mr. Edwards regarding the waste of public funds on road improvement work in the United States, as a result of the lack of business-like administration and engineering supervision, is confirmed by Mr. Paul D. Sargent, who held the position of assistant director, U. S. Office of Public Roads, at the time when he made a statement to the Third International Road Congress held in London, England, in 1913, to the effect that during the period 1904 to 1913, practically $1,000,000,000 of local revenue was expended through the agency of 2,900 county officials and 19,000 township officials, with little, if any, permanent improvements resulting. We are safe in assuming that municipal officials in Canada are no better fitted to supervise road construction work than are the local municipal officials of the republic to the south of us, and any person familiar with road construction problems, traveling through our provinces can see instances on every hand where considerable funds have been expended without obtaining tangible results.

**Common Errors of Location.**—During the 6 years that the writer has been connected with highway improvement work, he has had the privilege of examining a great deal of road construction in the various parts of this province, and reference should now be made to the most common classes of errors which have been observed and which are due to lack of engineering supervision.

The most frequent error in road construction work in this province is the adherence to road allowances when suitable grades can not be obtained or where the cost of improvements is excessive. Many thousand dollars are wasted every year on this class of road construction and in addition to the actual cost of such work there are accumulating losses, due to restricted tonnage and excessively high maintenance charges. Many such roads in this province have grades of from 10 to 11 per cent and eventually they are abandoned in favor of new locations where good grades can be obtained, often with the expenditure of a less amount than was wasted in attempting to adhere to original location. Had engineering advice been obtained before construction was undertaken, a profile of original road allowance could have shown that suitable grades were not obtainable.

When it has been decided to abandon the regular road allowance at some particular point, unskilled road builders often make grave errors in locating diversions. These errors are largely due to disregard of natural topographical features.

**Mistakes as to Culverts and Bridges.**—The construction of culverts and bridges of insecure design, unsuitable type of insufficient capacity, constitutes one of the most serious errors in road construction work, performed under the supervision of men lacking technical education. Errors of this nature, apart from being a waste of public funds, sometimes result in serious accidents. Numerous motor cars have been wrecked and many valuable horses killed as a result of defective culvert and bridge construction.

The designer of culverts and small bridges, not only requires a knowledge of the strength of materials, but should be able to calculate the maximum run-off from a catchment basin in cubic feet per second in order to determine intelligently the drainage capacity required. The installation of culverts and bridges of insufficient capacity not only results in the loss of the structures themselves, but invariably means considerable loss of embankment and serious inconvenience to the traveling public. The determination of the most suitable type of culvert or small bridge requires considerable engineering experience. We find frame-bent bridges on marshy ground and over swift-flowing streams, concrete bridges without the necessary foundation to prevent heaving, and deck spans where the height of embankment requires a concrete or corrugated iron culvert. Grave errors in location of culverts and bridges are also prevalent.

**Errors from Lack of Profiles.**—The lack of continuous fall in side ditches is a serious error in road construction work. Often the ditches are dug deeper at the lower points because more material is required to make the fill. The resulting pools saturate the foundation of the road and heavy traffic will then cause the road surface to become badly rutted. Profiles of all ditches should be prepared in order to secure continuous flow to the point of outlet whenever possible.

Another error due to the absence of profiles for the guidance of road foremen, is the improper determinations of the point at which the assumed grade line intersects ths natural surface of the hill, in order to given an economic balance between cut and fill. The writer has observed many instances where excavation was commenced at a point too near the foot of a hill, with the result that when the road was properly improved part of the original excavation had to be refilled. The construction of grades of uniform height across periodically flooded areas assumed to be level, but which in reality present difference of elevation of two or more feet and vice versa, the construction of grades of varying height across low areas of almost uniform elevation, are further evidences of the necessity of cross-sectioning road construction work, in order to prevent waste of material and unsatisfactory results.

**Improper Use of Side-Borrow and End-Haul.**—One of the principal errors of an economic nature is "side borrowing" in cases where "end-haul" would be cheaper when the general improvement of the road is considered, and vice versa, the construction of a fill by "end-haul" when "side-borrowing" would be more economical. The writer once observed a road foreman who had several years' experience in railway construction work undertake the building of a fill across a U-shaped ravine by side-borrowing in the bottom of the ravine. When the fill got so high that he was unable to continue this method, he resorted to the proper method of excavating on each bank, and depositing the material in the fill. Before the fill attained the required height the side slopes extended so as to completely fill the borrow-pits. The lack of economy in making an excavation for the purpose of refilling it, is apparent. This foreman had been accustomed to following the grade stakes set by an engineer, but when thrown upon his own resources he was entirely incapable of constructing a road in an economical manner; and although the case referred to may be a particularly striking example of this class of error, still, numerous cases exist where an unusually great waste of funds resulted from the adoption of the wrong method in the construction of a fill.

**Six Main Errors.**—Numerous examples of other classes of errors might be given, but it is not the purpose of this article to exhaust the subject nor to deal to any extent with the features which refer more to the execution of the work than to the design. The classes of errors already referred to embrace the most prevalent and outstanding examples of faulty road construction in Saskatchewan, due to the lack of engineering supervision, and these errors can be briefly classified as follows:

(1) To rigid adherence to road allowances.

(2) Disregard of topography in relocation.

(3) Improper location and construction of culverts and small bridges.

(4) Ill-designed ditches.

(5) Naked-eye levelling of heavy cuts and fills.

(6) Improper use of "side-borrow" and "end-haul."

**Road Supervisors Should Be Trained Engineers.**—It is true that there are many good road builders who have not graduated from technical schools, but these are exceptional and their experience is restricted to a narrow line of work, and their usefulness is curtailed by their limited education. Outside the range of their experience they have to depend on analogy and in so far as their education is incomplete they lack in efficiency. In the opinion of the writer, a thorough technical education is primarily necessary to properly equip a man as a road designer and builder. A general knowledge of the principles of engineering practice can be obtained by field experience, but an education obtained in this manner has certain restrictions to which reference has already been made. Having received a technical education preferably by a systematic course of training in an engineering school, years of practical experience on highway work is desirable, if not essential, to produce the proper balance between theory and practice. The personal characteristics of the individual largely determine his prominence in this as in any other profession, but generally speaking, it may be said that road supervisors should be engineers first and highway engineers afterwards.

## Engineer Officers Wanted

Another examination will be held in the near future for commissions in the Engineer Reserve Corps. Applications will be received from men engaged in the active practice of the engineering profession. The age limits are: For the grade of first lieutenant, 32 to 36 years; for captain, 36 to 42. These limits may be slightly increased or decreased in special cases, except that no one who is within the draft age will be sonsidered. The qualifications are an acceptable engineering training and experience, and a physical condition satisfactory to the medical officers of the Army. Application blanks can be obtained from Chief of Engineers, United States Army, Washington. If accepted for examination, the applicant will be notified when to appear before a traveling examining board, which is now making a tour of the country.

## Tar Treatment of Gravel and Macadam Streets at Stillwater, Minn.

During 1917 the city of Stillwater, Minn., applied a tar treatment to 7 miles of gravel and waterbound macadam streets at a cost of 10 ct. per square yard. The work was described by Mr. G. F. Barstow, City Engineer, in a paper presented at the annual meeting of the Minnesota Surveyors' and Engineers' Society, from which the following notes are abstracted:

A good many streets were rough and full of holes and these had to be repaired, which was done by filling the holes with gravel and thoroughly rolling it with a 15-ton roller. Where a street was rutted or badly out of shape it was given a coat of gravel about 3 in. thick and rolled in. On some streets where there were not too many holes no patchwork was done, this being left until the tar had been spread.

The tar was distributed by a spreading truck. Before the spreading, however, the streets were thoroughly cleaned of all dust and dirt, leaving the stone exposed as much as possible. The tar was then applied in two coats. One coat was put down on one side of the street and the other side left open to traffic. After that coat had laid about 24 hours, to give it a chance to thoroughly soak into the street, the second coat was applied and immediately covered with sand, enough sand being put on to completely cover all black spots. Men were kept along the street and as fast as the black showed up through the sand the spots were covered with more sand. The surplus tar would settle in the low places, and by keeping the spots where it soaked up through the sand well covered it had a tendency to level up the low spots and even up the street.

The covering sand was screened from bank gravel, being run over a ½-in. screen, and was then hauled to the street and deposited in piles along the gutters and spread with a shovel. One cu. yd. of covering sand covered about 112 sq. yd. of street.

As soon as the street was covered with sand it was thrown open to traffic and the other side was treated in the same manner. The traffic did not pick the material up once it is covered with sand, but ironed it down, and the more traffic it got the smoother the street became. A mistake was made on the first job by taking the covering sand from the road gravel pit; it contained too much clay, which powdered up and soon became dusty. The covering sand should be as clean as is possible to get, and about a week after the street is treated it should be swept clean so as to get rid of all the surplus sand that is not bound in by the tar. If the surplus sand it left it will soon grind up and become dusty.

The patching was done in the following manner: 6 bbl. of Tarvia K. P. was mixed, 1 bbl. to 2 yd. of gravel, in a mortar box in the same manner as if mixing a cement mortar. The mixture was hauled on a wagon along the street and enough deposited in each hole to fill it heaping full. One man went ahead of the wagon with a stiff broom and swept the holes clean and the steam roller followed the wagon and rolled the mixture into the holes, where it hardened, and in two days' time a person could not find where the patches had been made. Not over a 10-ton roller should be used for this work. Very good results were obtained by merely tamping the mixture into the holes. The cheapness of this method lies in the fact that it is necessary only to use enough of the mixture to fill the holes and it will not sluff out, and where a person would probably use a whole load of gravel to patch a hole in an ordinary gravel road a few shovelfuls of this mixture will do the trick.

## General Limiting Test Values for Broken Stone

To interpret the results of the physical tests of road building rock the U. S. Office of Public Roads has adopted the following table of general limiting test values for broken stone for the various types of road construction.

This table is printed on the back of the form used by the Office for reporting tests. By comparing the results of the tests on a sample of rock with the limits shown in the table, a general idea of the types of road construction for which it is best suited may be obtained. The table, together with comments upon the limits shown, is reprinted here from Bulletin 670 issued last month by the Department of Agriculture:

GENERAL LIMITING TEST VALUES FOR BROKEN STONE.

| | | Limiting values | | |
|---|---|---|---|---|
| Type of construction. | Traffic.[1] | French coefficient of wear. | Touchness. | Hardness. |
| Water-bound macadam, plain or with dust palliative treatment | Light | 5 to 8 | 5 to 9 | 10 to 17 |
| | Moderate | 9 to 15 | 10 to 18 | 14 or over |
| | Heavy | 16 or over | 19 or over | 17 or over |
| Macadam with bituminous carpet | Light to moderate | 5 or over | 5 or over | (2) |
| Bituminous macadam with seal coat | Moderate to heavy | 7 or over | 10 or over | |
| Bituminous concrete | Light to moderate | 7 or over | 7 or over | (2) |
| | Moderate to heavy | 10 or over | 13 or over | |
| Binder course for sheet asphalt or Topeka type | Any | 7 or over | 6 or over | (2) |
| Portland cement concrete | Moderate to heavy | 7 or over | 8 or over | |
| Stone paving block[3] | Any | 8 or over | 9 or over | 16 or over |
| Broken-stone foundations | Do. | 3 or over | 3 or over | 8 or over |
| Cement-concrete foundations | | | | |

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[1] Light traffic is assumed as less than 100 vehicles per day, moderate traffic between 100 and 250 vehicles, and heavy traffic over 250 vehicles per day.

[2] Numerous tests have shown that limits for hardness are unnecessary if the material possesses the required French coefficient of wear and toughness.

[3] Crushing strength, 20,000 lb. or over per square inch, is frequently required.

Cementing values should in all cases show over 25 if material is to be used in water-bound macadam construction.

Granites, gneisses, schists, sandstones, and quartzites should not, in general, be used in the wearing course of water-bound macadam roads. Shales and slates should never be used in this connection. Cementing value tests have therefore been discontinued on these materials.

## Increased Cost of Labor and Materials in New York State Road Work

In a statement given out recently by the Empire State Contractors' Association of Buffalo, N. Y., the following examples are given to show the increased cost since war began of various items entering into road contracts in New York State:

Freight has advanced, including the war tax, in most instances 40 per cent.

Freight on cement has increased 50 ct. a ton.

Labor has gone from 15 ct. to 40 ct. an hour and in some places to 50 ct. an hour and is then not to be got.

Foremen's pay has increased from $20 a week to $40.

Crushed stone has advanced 100 per cent.

Cement has advanced 50 per cent.

Sand has advanced from 50 to 75 per cent.

Concrete mixers have advanced $1,800 to $3,500 with corresponding increase in repair parts costs.

Railroad fares which must be paid men in many instances have advanced 50 per cent.

The cost of machinery has gone up 100 per cent.

Iron and steel pipe used extensively on roads has gone up when necessary to replace from 12 to 33 cents a foot.

Tools of all kinds, including shovels, picks and wheelbarrows, have gone up 100 per cent.

Liability and compensation insurance has increased 100 per cent.

## $280,000,000 Spent in 1917 on Rural Roads and Bridges

Cash expenditures on rural roads and bridges in the United States in 1917 amounted to $279,915,000, according to an article prepared in the Management Branch of the U. S. Bureau Public Roads by Andrew P. Anderson, Highway Engineer, and printed in Public Roads. To this should be added the value of statute and convict labor, which can not be fixed to any great degree of accuracy, but probably amounts to not less than $15,000,000, thus making the grand total expenditure for the year $295,000,000. This total is made up of the actual expenditure of such items as labor, materials, supervision and administration directly connected with the construction, improvement and upkeep of our public roads and bridges, and does not include interest on bonds and other outstanding obligations.

The expenditures on our city, town and village streets are not included in the above figures. However, the expenditures on account of streets are estimated in the article to amount in round numbers to $300,000,000 annually.

From 1904 to 1916 the average annual increase in the total rural road and bridge expenditures was about 10 per cent over and above those of each previous year. During the years 1916 and 1917, however, this increase was reduced to about 2 and 3 per cent, respectively. This, however, does not signify any general decline in road work. On the other hand, the reverse is true. The expenditures by or under the control or supervision of the several state highway departments have steadily continued to increase. Thus, while the total amount of funds expended by or under the supervision of the state highway departments in 1917 exceeded those of 1916 by more than 30 per cent, the total expenditure of strictly local funds by the local communities during the same period decreased 10 per cent.

The amount of state funds devoted to road and bridge work continue to show a large annual increase. In 1904 11 state highway departments expended a total of $2,550,000 for road and bridge work, and in 1914

31 state highway departments expended $24,221,000, while in 1917 every state in the union made some contribution to this work, which amounted to a grand total of $47,291,000 of state funds as distinguished from local funds. Furthermore, the utilization of convict labor in road work or the preparation of road materials under competent state supervision is coming to be a more and more important factor, while the employment of statute labor or working out the road and poll taxes is decreasing from year to year. In one-half of our states the use of convict labor in road work under the state direction or control has definitely passed what may be called the experimental stage and proved a success.

One of the most notable features in the increase in the amount of funds expended under the supervision or control of the several state highway departments is that relating to maintenance. In 1914 the several state highway departments directed the expenditure of $16,343,000 for maintenance. In 1916 this had increased to $18,453,000, while in 1917 it had grown to $27,648,732. This increase is in part due to the heavier traffic and the rising prices of labor and materials, but more largely to the growing tendency to centralize the control of all our important highway work under competent state control or supervision.

On the other hand, the ever-increasing demands on our roads by the present-day traffic are compelling more substantial improvements as well as better maintenance methods, regardless of price and conditions. The reasons for these increasing traffic demands are readily apparent. At the present time approximately 5,000,000 motor vehicles, of which about 10 per cent are motor trucks or commercial vehicles, are used on our public roads and streets. These motor vehicles represent a maximum potential traffic capacity of certainly not less than 1,000,000,000 vehicle miles per day and a total horsepower of at least 120,000,000. Fifteen years ago all traffic on our roads may be said to have been horse-drawn. Today, in addition to the horse-drawn traffic, which is probably nearly as large as ever except in regard to pleasure vehicles, we have this enormous motor vehicle traffic. Even in such a representative agricultural state as Iowa, the average of 7-day counts recently made by the Iowa State Highway Commission and Iowa State College (at 47 stations in 17 counties) showed that the horse-drawn traffic formed less than 14 per cent of the total. It can, therefore, readily be seen why the traffic demands on the roads of today are so much greater than those of a few years ago.

The public rural roads of the United States at the present time have a total length of 2,457,334 miles, of which about 296,290 miles or 12 per cent are improved with some form of surfacing. The mileage of hard surfaced roads has for a number of years been increasing at the rate of about 15,000 miles per annum. During 1917 it is estimated that this mileage was somewhat reduced, amounting to about 14,000 miles. Of this mileage about 7,000 miles were surfaced under state supervision and also about 5,000 miles were improved by grading or otherwise. Thus, of the actual road construction work of a more or less permanent nature in the United States last year, more than one-half was directly under competent state supervision. In addition to this work of construction the several state highway departments also supervised the maintenance of 181,000 miles, most of which were main and truck line highways.

## Underground Study Preliminary to Street Paving

At Hartford, Conn., after the streets to be paved are decided upon, a study is made by the Engineering Department to determine whether or not the wires of the various public service corporations are provided for by underground conduits. For this purpose so-called underground maps are prepared to a scale of 20 ft. to the inch. Such a scale makes it necessary to have a large number of individual maps, but, on the other hand, with a smaller scale it would prove difficult or impossible to show clearly all of the details necessary. These records are made on tracing cloth and the adoption of a color scheme whereby the lines of the different companies are always shown by a certain color makes them clearer than would otherwise be the case.

When the investigation discloses the fact that there is no underground service for a certain company, a location is worked out for them and a comprehensive development of the sub-surface mapped out to best serve the needs of all parties concerned. By law, the city may order each public service corporation maintaining overhead wires to place not more than 2 miles of these wires in underground conduits each year. The companies may find it necessary to construct duct lines in excess of 2 miles in order to accommodate the new pavements which they usually prefer to do rather than be put to the expense of replacing the pavements for the installation at some later date.

Several months previous to the laying of the pavement, all public service corporations as well as all abutting property owners are notified by mail to install any contemplated new work or to repair any existing services before a certain date. This with an object to have all such work out of the way before starting in on the paving of the street and to prevent, as far as possible, the tearing up of the pavement for such purposes after it is laid.

**State Highway Department Not Required to Make Road Repairs in Boroughs.**—The State Supreme Court of Pennsylvania handed down a decision last month that the State Highway Department cannot be forced to rebuild and keep in repair that portion of a road taken over by the state which extends through a borough. Gettysburg mandamused the state to repair part of an Adams County turnpike which the Highway Department had acquired, but the Dauphin County Court held that the state cannot be forced to build or repair a road in a borough. An act of 1917 provided money for the building of roads along state routes in boroughs, but the decision for the necessity of such work rests with the department.

**21,771,000 Sq. Yd. of Concrete Paving in 1917.** Over 21,771,000 sq. yd. of concrete pavement was placed under contract in the United States during 1917, according to statistics collected by the Portland Cement Manufacturers' Association. Of the total 15,333,087 sq. yd. were for roads, 5,238,062 sq. yd. for streets and 1,200,030 sq. yd. for alleys.

**Commission to Act in Civic Disputes.** Representatives of Iowa municipalities and public service corporations have appointed a public utility commission of five members to act in conjunction with the federal courts in settling differences arising between municipalities and their service corporations.

## Gouge Soft Spots Out of Concrete Pavements

In laying concrete pavements, after the top has been surfaced and left to harden but before the covering of earth is thrown on, a careful inspection of the surface should be made. By the time the concrete has set long enough to sustain a man's weight without showing, small bright and shining spots will be seen on the surface. They may be few and far between or there may be a great number of them. If the inspector will insert his pocket knife into these bright places he will find them soft in comparison with the rest of the surface. It will be found that these soft spots are earth or some kind of clay or loam, or a lump of sand, wood, coal or soft stone. All this soft material should be dug out, the holes cleaned and then filled with fine and rich concrete, filling the holes a little more than full. In spite of all the care possible in providing clean and pure material, it is impossible not to have some foreign matter get into the concrete, and the adoption of the foregoing kink will prevent many a hole in the surface of a concrete pavement, especially if the stone constituent of the concrete is gravel.—Walter E. Emery, Supt. of Highways, Peoria, Ill., in Concrete.

## Cost and Working Data of Steam Motor Wagons

In the Surveyor and Municipal and County Engineer, the County Surveyor of Notts, England, gives the subjoined details of the cost and working of two steam wagons purchased by his Highways Committee:

| | Burrell. | Clayton & Shuttleworth. |
|---|---|---|
| Date purchased | November, 1915 | July, 1916 |
| Cost with two trailers | £800 | £850 |
| Working period up to March 31, 1917 | 12 months | 8 months |
| Working costs— | £. s. d. | £ s. d. |
| Wages | 144 7 9 | 123 0 8 |
| Coal | 80 4 1 | 60 9 0 |
| Oil | 8 16 9 | 6 0 10 |
| Repairs, tires, etc | 103 10 9 | 33 7 2 |
| | 336 19 4 | 222 17 8 |
| Add depreciation at 12½ per cent | 100 0 0 | 70 16 8 |
| | 436 19 4 | 293 14 4 |
| No. days worked | 257 | 207 |
| No. loads hauled | 847 | 744 |
| No. tons carried | 7,513 | 6,602 |
| No. miles traveled | 5,080 | 3,357 |
| No. miles traveled loaded | 2,540 | 1,678 |
| No. tons hauled per journey | 8.87 | 8.86 |
| Cost per day | £1 14s 0d | £1 8s 4½d |
| Cost per mile | 3s 5¼d | 3s 6d |
| Cost per 10 miles | 4.65d | 4.75d |

From this it will be seen that the cost of hauling the material dealt with was 4¾d. (9½ ct.) a mile. Wagons were bought on the estimate that the hauling would come within the figure of 5d. (10 ct.) per mile, and despite increase of wages and prices of materials, the haulage will probably continue to be carried on within this rate. Without these two wagons it would have been impossible to carry out the work dealt with.

**New Charter for Detroit, Mich.**—The citizens of Detroit, Mich., by a vote of 32,297 to 4,539 approved a new charter. Under this the mayor is given large powers of control and is directly responsible for all branches of the municipal government. He will have authority to appoint, without confirmation by the council, and for indefinite trems, various municipal officials, such as Commissioner of Public Works, buildings, parks and boulevards, etc. The new charter provides for the initiative, referendum and recall.

## Personals

E. H. Jeffries has been appointed city engineer of Manteca, Cal.

J. H. Henry has resigned as city manager of Gary, Fla., and has joined the Army Engineer Corps.

Edgar M. Hoopes, Jr., has resigned as city engineer of Wilmington, Del., to accept a position with the Government.

A. E. Hutchison, municipal engineer of Albuquerque, N. Mex., has been commissioned a first lieutenant of U. S. Engineers.

Thomas E. Laws, 805 N. 20th St., Philadelphia, Pa., has been appointed assistant engineer, Bureau of Surveys, of that city.

J. H. Moore has resigned as city manager of Sault Ste. Marie, Mich., and for the time being Wilder Rich, city engineer, will act as manager.

Jack Charlton of Savannah, Ga., has been appointed city engineer of Brunswick, Ga., succeeding J. B. High, who resigned two months ago.

Harvey Booth has been appointed city manager of Glasgow, Mont., succeeding Charles H. Blitman, who has joined the Aviation Corps.

John L. Hyde, for the past 7 years town engineer of Westfield, Mass., has resigned that position to become an engineer for the Emergency Fleet Corporation.

R. M. Cooksey, highway engineer of the city of Baltimore, Md., has been commissioned major of the Construction Division of the Quartermaster's Department, U. S. A.

David C. Morrow has resigned as City Engineer of Washington, Pa., having been commissioned a captain in the Sanitary Department of the U. S. Engineer Corps.

John F. Mullin, a civil engineer of Wilmington, Del., who enlisted in the aviation corps at the breaking out of the war, has been commissioned a first lieutenant in France.

George M. Zimmerman has reconsidered his resignation as City Manager of Sandusky, O., and will continue in that position. The City Commission has advanced his salary from $3,600 to $5,000.

Captain Howard S. Porter of Hartford, Conn., has been promoted to the rank of major in the 301st Engineers. He formerly was chief draftsman in the Connecticut State Highway Commissioner's office.

Allen G. Lincoln, division engineer of the Victor American Fuel Co.'s mine at Chandler, Colo., has been appointed assistant district engineer in the Denver district of the United States forest service.

H. H. Esselstyn of the firm of Esselstyn, Murphy, Hanford, engineers and architects, has been appointed Director of Public Works of Detroit, Mich. At the time of his appointment Mr. Esselstyn was engineer for the U. S. Shipping Board.

Charles LeD. Gambrill has been appointed city purchasing agent of Baltimore, Md., to fill the vacancy made by the departure from the city of Philip W. Tucker, who accepted a captain's commission in the Quartermaster's Department.

O. E. Carr has resigned as City Manager of Niagara Falls, N. Y., to accept a similar position at Springfield, O., succeeding Mr. Ashburner, who has been appointed City Manager of Norfolk, Va. Mr. Carr became City Manager of Cadillac, Mich., in April, 1914, at a salary of $3,000 per year. In January, 1916, he became City Manager of Niagara Falls at a salary of $5,000.

Winton L. Miller has been appointed the first city manager of Bethlehem, Pa. Mr. Miller served as executive secretary to City Manager Waite of Dayton, O., until called to St. Augustine, Fla., in August, 1915, as city manager. He resigned this spring to accept a Government position at Hog Island. His salary at St. Augustine was $3,600 per year. It is reported that he receives as city manager of Bethlehem about $10,000 per year.

A. R. Hebenstreit, county engineer of Tama County, Iowa, has been appointed city manager of Albuquerque, N. Mex., at a salary of $3,600. He succeeds Paul G. Redington, who resigned to resume his duties as District Forester in the U. S. Forest Service. Mr. Hebenstreit is a graduate of engineering department of Notre Dame. In 1913 and 1914 he was in charge of reconstruction of yards and the water system at Council Bluffs, Iowa, for the C., M. & St. P. R. R., and also in charge of terminal construction. He also has been draftsman and accountant in railway valuation work for the Great Northern Railway. He has been county engineer for the past 3½ years.

## Obituaries

Dr. John Duir Irving, professor of economic geology at Yale, died of pneumonia in France, where he was in the engineering service with the American Expeditionary Force.

William L. Dickinson, aged 66, a good roads builder of national reputation, and from 1889 to 1899 superintendent of streets in Springfield, Mass., died July 4 at his home in that city. When he was elected superintendent of streets in 1889 he introduced the first steam roller into street work at Springfield. He and others were influential in the organization of the first State Highway Association in 1891. He was president of it for one year and treasurer for three years.

James Wilson, for the past 11 years County Engineer of Newcastle County, Delaware, died July 29 at his home near Wellington, aged 60. Mr. Wilson after graduating from Lafayette College became the private secretary of Senor Cisneros, a wealthy Cuban and railroad builder. With Senor Cisneros, Mr. Wilson spent a year in Europe and then they went to South America where Mr. Wilson spent 10 years, building railroads in the interior along the Magdelena river. Early in the project Senor Cisneos died and Mr. Wilson became chief engineer, carrying the work to its completion. After completing his work in South America, Mr. Wilson was appointed city engineer of Wilmington, Del. He later did some work for the Pennsylvania railroad in Western Pennsylvania and on his return was again appointed to the office of city engineer from which he resigned to fill the office of county engineer, 11 years ago.

*Waterworks and Hydraulics*
*Monthly Issue*

# ENGINEERING *AND* CONTRACTING

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**Roads and Streets—1st Wednesday**
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies

**Waterworks and Hydraulics—2nd Wednesday**
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power

**Railways and Govt. Works—3rd Wednesday**
(a) Excavation and Dredging (c) Harbors and Docks
(b) Rivers and Canals (d) Railway Construction

**Buildings and Structures—4th Wednesday**
(a) Buildings (c) [illegible]
(b) Bridges (d) [illegible]

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## Why Most of the Inventions for War Purposes Are Useless

Correct reasoning on economic matters is not possible in the absence of quantitative data. Probably three-fourths of all reasoning may be classed as economic. Economy is the judicious use of labor, other energy and materials in the attainment of a desired end. It is apparent to an engineer, therefore, that economy requires a knowledge of quantities of energy and materials (the latter being the "products" of energy). But to relatively few people other than engineers and scientists is it clear that correct economic reasoning is based on quantitative knowledge. For example, hosts of would-be inventors are flooding our war department with suggested devices for winning the war. One comes with a plan to snatch the guns from the Huns with electromagnets suspended from balloons. Another would use magnets to deflect torpedoes from an attacked vessel. A third would even pull a submarine from the depths with magnets. We have selected these magnet schemes as an illustration because they serve exceedingly well to show how futile reasoning may be if only qualitative knowledge is involved without adequate quantitative knowledge.

Magnets have the quality of attracting iron and steel; and, based on a knowledge of this quality, it seems feasible to many inventors to perform feats like those above mentioned. But a certain quantitative fact stands in the way of the proposed achievement. A magnet, whether permanent or electric, has almost no attractive power beyond a very limited distance. One need not be acquainted with the complete mathematical theory of magnetism (as given in such profound works as Jean's Electricity and Magnetism) to appreciate how limited is the field of induced magnetism. Take even a little horseshoe magnet and observe its failure to move a pin that is half an inch distant; and contrast that lack of pulling power with its relatively great pull when the pin is only an eighth of an inch away. Similarly as the pulling power of the huge electro-magnet used in lifting great weights of iron or steel, even the crudest observation of the very rapid decrease of pulling power with increasing distance should make it clear that distance is a very important factor in any problem involving magnetic attraction.

Distance is a quantitative factor which these qualitative "inventors" of magnet war schemes ignore. Their quantitative ignorance therefore dooms their plans to failure.

Analysis of a great number of chimerical schemes of would-be inventors has made it clear to the editor that the fundamental error in most of them has occurred because the inventors lacked quantitative knowledge. "A little knowledge is a dangerous thing," particularly when it is purely qualitative.

The ordinary run of men, even many of those who account themselves educated, fail to appreciate the real power of engineering knowledge because they fail to understand the wide gap between mere qualitative knowledge and knowledge that is quantitative as well as qualitative. They know, of course, that an engineer must have quite an extensive knowledge of the science of quantitative relations, mathematics, but what they do not understand is that mathematics is now applied in almost every branch of human knowledge, and with astonishing results. Cost analysis, strengths of materials, surveys of distances and areas—all such relatively simple applications of mathematics the average man can appreciate. But he begins to become hazy in his conceptions when you tell him that chemistry and electricity are now very largely reduced to mathematical laws; and that, guided by such laws, engineers can predetermine the economic possibilities of a vast number of "novel" ideas.

One war inventor would petrify the enemy soldiers by deluging them with portland cement grout. A little quantitative thing like the time element in the hardening of the cement—several hours—makes his scheme seem like a joke; but to him the plan was entirely serious, for all he knew about cement was its quality of hardening into rock.

Showing how gullable most men are where an alleged invention is concerned, take the recent instance of the investigation of "Garabed" ordered by Congress. Here was an inventor who claimed to have discovered how to "create" power by a secret process, and practically without cost. Asked for his credentials, he produced only letters affirming belief in his honesty—not a letter stating that he had the slightest quantitative education or experience in the matters relating to power production. It never occurred to Congress that quantitative knowledge is essential in solving economic power production problems. True, by some inspiration or accident an ignorant man might discover a novel and economic means of producing power. But if time and money are to be spent in investigating claims that are not even accompanied by quantitative data, would it not be equally sound economics to investigate every old housewife's remedy for croup or a cold in the head?

In this connection it may be pointed out that Congresses, composed as they are largely of men having very limited knowledge of applied mathematics, inevitably blunder in nearly all acts that involve the solution of economic problems. And since most of their problems are economic, the records of one Congress after another are mostly records of incompetency. Is it a question of paying bonuses to men working in Government factories? Congress does not ask for the economic or quantitative results of bonus payments in other factories. Congressmen can reason out the answer without bothering with "figures," and they do, resulting in the uneconomic prohibition of bonus payments. Is it a question of railway or telephone or telegraph operation? Congress seeks no data to establish the economy of Government versus company operation. Congressmen have merely to look into their own hearts to know that, at least during the war, such utilities should be operated by the Government. And so it goes. The great majority of important congressional decisions have rested on mere qualitative reasoning, and therefore were almost as certain to be erroneous as the reasoning of the inventor who would pull U-boats from the "vasty deep" with magnets floating on the surface above.

## Is the "Per Consumer" Unit More Preferable to the "Per Capita" Unit of Water Consumption?

A contemporary contends that city water consumption should be expressed in gallons per day per consumer rather than in gallons per day per capita. It is pointed out that in some cities many of the residents secure their water from private wells, and that some cities sell water to residents outside the city limits. In either of these cases a city per capita statement of water consumption is apt to be misleading. But if the per capita unit is objected to on such grounds, the per consumer unit is equally objectionable on similar grounds. A factory is a single consumer, but it may use more water than a thousand residential consumers. The city itself is a single consumer, but it may take 10 per cent of all the water for sewer flushing, street sprinkling and flushing, etc.

Unless industrial and municipal uses of water are somewhat similar in two cities, and unless the cities are somewhat alike as to the per consumer areas of lawns and gardens, and unless the rainfall conditions are similar, and unless the winter temperature curves are about the same, the respective per consumer use of water will differ quite as much as per capita use commonly differs.

Undoubtedly it is wise to estimate water used per consumer as well as per capita, but let it not be supposed that any single unit of water consumption is very satisfactory for comparative purposes unless all conditions are proportionately the same.

The word "consumer" needs definition, for it may mean either an individual who uses city water or a customer who uses it. In the latter case the number of active service connections is ordinarily very nearly equal to the number of "consumers." But if the number of consumers embraces all users of the city water, then it becomes necessary to take a periodic census of all users.

## Inadequate Water Rates Due to Ignorant or Unfair Politicians

The average hydrant rate in America is said to be about $40 a year; and, as every experienced appraisal engineer knows, such a rate is far below an equitable amount. Nevertheless, whenever a water company having low hydrant rates seeks to secure even $40 a year, the City Council almost invariably fights the increase. Thus at Bloomsburg, Pa., the water company has recently asked for only $25 a year per hydrant, instead of the present $10 and $15 rates; and press reports state that the City Council is opposing the increase, but may compromise with the company!

Oh, ye wise and fair "city fathers" of Bloomsburg, how well ye guard the public treasury! What matters it that the water company modestly seeks a new rate that is not half what a fair rate would be. Yours the duty to bargain and haggle, and force, if possible, a miserable "compromise" between the $15 that is and the $25 that is asked. Small wonder that capital has long ceased to seek employment in the water works field, and is fast coming to regard every sort of public utility as the poorest of investment places.

Instead of leaving rate matters to fair-minded and competent engineers and commissions, local politicians usually undertake to control public utility rates; and where the law prohibits such control, still they do all in their power to make it impossible to operate a public utility at a profit. They foster the operation of jitneys to take the only profitable business—the short-haul business—from the street railways. They raise tax values of utility companies far above all other values. They call for extensions into sparsely settled territory. And in a hundred ways reduce net earnings, but remain ever alert to prevent a utility company from getting a fair return on its investment. We wonder how many of the taxpayers would countenance such actions of their "representatives" if they knew all the facts.

## Drafting an Entire Profession

The Government is about to subject the members of the entire medical profession to its orders. There are 140,000 doctors of whom 90,000 are in active practice. About 23,000 are already in the service of the army and navy, but nearly 50,000 will be eventually required for war service. At first a voluntary enrollment plan will be tried, but if that is not satisfactory there will be legislation providing for the drafting of physicians. To engineers this step is of interest, because it indicates the Government's determination to secure by law all the needed professional men if they can not be secured by voluntary action. There has been no scarcity of engineering volunteers as yet, and we look for none. Indeed, engineers have come forward to serve their country faster and in greater numbers than was needed. Nearly 10,000 engineer officers are now commissioned and in service. This does not include thousands of engineers not commissioned, but working for Uncle Sam. The last U. S. census showed 100,000 technical engineers of all classes. We venture to say that fully 50,000 are now serving their country. It must be remembered that nearly all civil, mechanical and electrical engineers on our railways are now Government employes. Add to these the engineers engaged by companies that have Government contracts for ships, buildings, steel, etc., and it becomes apparent that American engineers far outstrip every other civil profession in numbers now serving their country.

## Contrast the Salaries Paid by Cities to Their Engineers With Those Paid by Schwab to His Engineers

Democratic governments are notorious for not paying adequate salaries to the employes having the greatest responsibility—the planners and managers. They willingly—often too willingly—raise the wages of employes in the ranks, while remaining obdurate to requests for higher salaries for men in professional and managerial positions. Robert Hoffman, Commissioner of Engineering of Cleveland, has said:

> Unfortunately, the personnel of the Sewer Department has changed frequently from one cause or another so that but few men have had an opportunity to become thoroughly acquainted with local conditions or well versed in the science of sewer design. Salaries should be adjusted from time to time so as to make an inducement for competent engineers to remain in the employ of the city as well as to make the securing of their services possible. Engineers as a whole should be interested in this phase of the problem, as it means proper recognition of the profession and adequate reward for most useful service.

This condition is typical and deplorable. If it is ever to be remedied, Mr. Hoffman's suggestion must be acted upon. Engineers as a class must interest themselves in the problem of securing adequate salaries for engineers and managers employed by cities. Even though they run the risk of being charged with working for a selfish purpose, engineers should undertake to convince city councils and the public that it pays a city, in the long run, to employ the best of engineers and executives, and that such men can be retained indefinitely only by those who pay them adequately. Adequately does not mean the least that such men will accept for temporary employment, but enough to make a city positon as attractive as a position with a prosperous and well managed company.

The public is at present well informed about that great engineering executive and manufacturer, Schwab. Let the public also know something about Schwab's practice as to the salaries of his engineers and managers. No city is likely ever to duplicate the salary that Schwab pays to Grace, the president of the Bethlehem Steel Co.—a million dollars a year—but every one in authority in every city should be told that Grace is an engineer, and that Schwab's success as a manager rests largely upon the liberal compensation that he gives his ablest engineers and managers.

**Central States Water Works Convention.**—The next annual convention of the Central States Division of the American Water Works Association will be held Sept. 25-26 at Pittsburgh, Pa. R. F. Bucker, Shelby, O., is Secretary of the Division.

## Clipping Articles From Technical Journals for Filing

To the Editor: In a recent issue of Engineering and Contracting it was stated, in substance, that the value of a periodical to an engineer was in direct proportion to the number of articles clipped for preservation or filing. In that I heartily agree and am pleased to state that I find Engineering and Contracting especially valuable in that respect. There is never an issue from which I do not clip and file one and generally several articles of especial interest and value. They are often articles I do not find in any of the other periodicals that reach my office. Clippings so made are filed with other data by the Dewey system which I adopted some 18 years ago.

In making clippings I find one great (to me) defect in the arrangement of substantially all periodicals. I refer to the fact that important articles often commence at any place convenient for the publisher or printer, thus often necessitating not preserving an article of more or less value because a portion of it appears on the one cut out. In the case of monthly periodicals arranged like the popular monthlies, or annual paper bound reports, such as those of the various State departments, this defect could be easily and cheaply remedied by commencing each important article or paper always on the right hand page of the open book, i. e., in the same manner as the Papers and Discussions are arranged in the monthly Proceedings of the American Society of Civil Engineers. I fully recognize the difficulty of such an arrangement for a periodical like Engineering and Contracting, but believe that with editing it with that end in view the result might be largely attained. Small and more unimportant articles could be used to fill out the left hand page, and even these articles might often be of such a nature as to bear the same Dewey Index number as the major preceding article.

By commencing each paper on the right hand page of the open book, there should be and undoubtedly is a material saving in expense of printing each paper separately, as is frequently done in the case of papers in technical society proceedings. The cost of the extra blank page is not proportional to the average printed page cost, but assuming it to be the same in cost, it is found that in 1917 the American Society of Civil Engineers printed in its monthly Proceedings 108 separate papers and discussions, requiring 2,361 pages, of which 53, or about 2.3 per cent, were full page blanks, representing a cost to the Society of less than $600. The New England Water Works Association printed in its quarterly Journal for 1917, 33 separate papers on 558 pages. It could have commenced each paper on the right hand page by the addition of 20 blank pages, representing a cost of about $150. The American Water Works Association printed in its Journal for 1917, 56 separate papers on 502 pages and could have commenced each paper on the right hand page by the addition of 22 blank pages, at a cost of about $200. As the subject matter in these last two periodicals refer almost wholly to water works matters, I find it necessary to preserve the issues intact, requiring valuable shelf room and becoming after a few years inconvenient for reference, whereas, by the arrangement suggested above, the papers could be separately filed where readily accessible. An examination of several other periodicals reveals a similar defect. The subscribing for two copies where one should suffice would be a burdensome expense, and cross references would be an inconvenient remedy, as articles relating to one subject or subdivision thereof are all put in one or more folders and given the proper Dewey Index number, the folders being filed numerically.

CHARLES C. HOPKINS,
Rochester, N. Y. Consulting Engineer.

## Thawing Services With Hot Water and With Electric Outfit

The extremely cold weather of last winter cost the Water Department of Milton, Mass., over $4,000 for thawing services, replacing burst meters, and for excess water consumption. The experiences of the town were described by Mr. D. A. Heffernan, Superintendent of Waterworks, in a paper read before the New England Water Works Association, from which the following notes are abstracted:

Thawing operations consisted of running a 3/16-in. block-tin tubing through which boiling hot water was being pumped continuously into the service. This method proved entirely satisfactory during the first of the cold weather when services were freezing from the cellar wall out toward the street, but was not efficient when the frost had worked its way 5 or 6 ft. into the ground, as it did in some places, and the services froze in the street.

The majority of the services laid to ordinary single houses 15 or 20 years ago were ⅝-in. lead, and it is impossible to push a block-tin tube, softened by hot water, to a great distance through small lead pipe laid without particular attention being paid to its straightness.

The average length of the services is 107 ft. and when they began to freeze in the street, in the majority of cases, 50 ft. of tubing could be pushed into the service without even reaching the ice.

An electric thawing apparatus was placed in operation on Jan. 26, and from that day to the last day of February was kept busy.

The apparatus consisted merely of a switchboard containing fuses, meter and switch, and a transformer and rheostat. It was necessary to take the current from the Edison primary wire carrying a voltage of 2 300. The current passed through the switchboard to the transformer, where its voltage was cut from 2 300 to 110, and from there to the rheostat, which consisted of a hogshead containing a solution of common salt and having a metal plate solid on the bottom and another plate which it is possible to raise or lower to regulate the amperage.

From the rheostat the current followed the secondary wire of 4-0 insulated cable which was clamped to the service pipe in the cellar of the house to be thawed, out through the service to the main, which it followed to the hydrant, to which the other secondary wire was connected; then back through this wire to the rheostat, transformer, switch, and finally to the primary again.

The amperage used on different services varied considerably. Where long connections were needed, the greatest amperage sometimes was only 150; at other times 500 amperes were used, while the ordinary amount averaged 350.

During 31 days, 140 services were thawed, of which 20 were private (being runs from a house to a stable, garage or greenhouse, and laid by the consumer), 4 hydrant branches, and a couple of short stretches of dead ends.

The average cost of thawing a service was $12.46. Of course a short service cost considerably less, the average being brought up because of the time consumed in the long jumps between jobs.

The average daily consumption jumped from 375,000 gal. to 500,000, during the period, as the water department had recommended every consumer to open one faucet enough to allow a ¼-in. stream to flow.

The estimate of the cost of the cold weather to the department follows:

| | |
|---|---|
| Labor cost in excess of regular pay roll | $ 847.29 |
| Cost of electric thawing apparatus | 1,472.23 |
| Estimated cost of burst meters, 150 at $5 | 750.00 |
| Excess of water consumed—125,000 gal. daily for 65 days at $0.1336 per 1,000 gal. | 1,085.50 |
| Total | $4,155.02 |

From this must be deducted $545, to be charged against private work. It is not the intention of the department to charge the consumer for water used to prevent freezing, burst meters or thawing out, as they were not happenings caused by undue carelessness of the consumer. At the town meeting, an appropriation of $3,500 was granted to cover partially the expenses of the cold weather.

## Employees School Maintained by St. Louis Water Department

The Water Department of St. Louis, Mo., maintains an intelligence bureau which holds a school for one week's duration twice each year. At these sessions all employes of the distribution system attend, especially the newcomers, who are fully initiated in the art of cutting pipe, yarning, and pouring joints, caulking, assembling hydrants and valves, rigging derricks, the use and names of various tools, and all other little details with which all distribution employes should be familiar. These sessions are generally attended by department engineers, and often the exchange of ideas proves as beneficial to the superiors as to the subordinates. The professor in charge is generally a graduate of the ditch, who has advanced step by step in the service, and is capable of showing the principles by actual demonstration. By teaching the employes the use of tools and allowing them to do the actual work in these practice sessions, the department always has on hand an adequate corps of capable men who can assume the different positions when the occasion demands without crippling the service.

## Cost of Filtering Water at Grand Rapids

The cost of filtering water at Grand Rapids, Mich., increased from $14.87 per 1,000,000 gal. for the year 1916-17 to $18.84 in 1917-18, according to the annual report of Walter A. Sperry, chief chemist of the filter plant. Comparative figures on the operating costs for the last four years are given in the report, as follows:

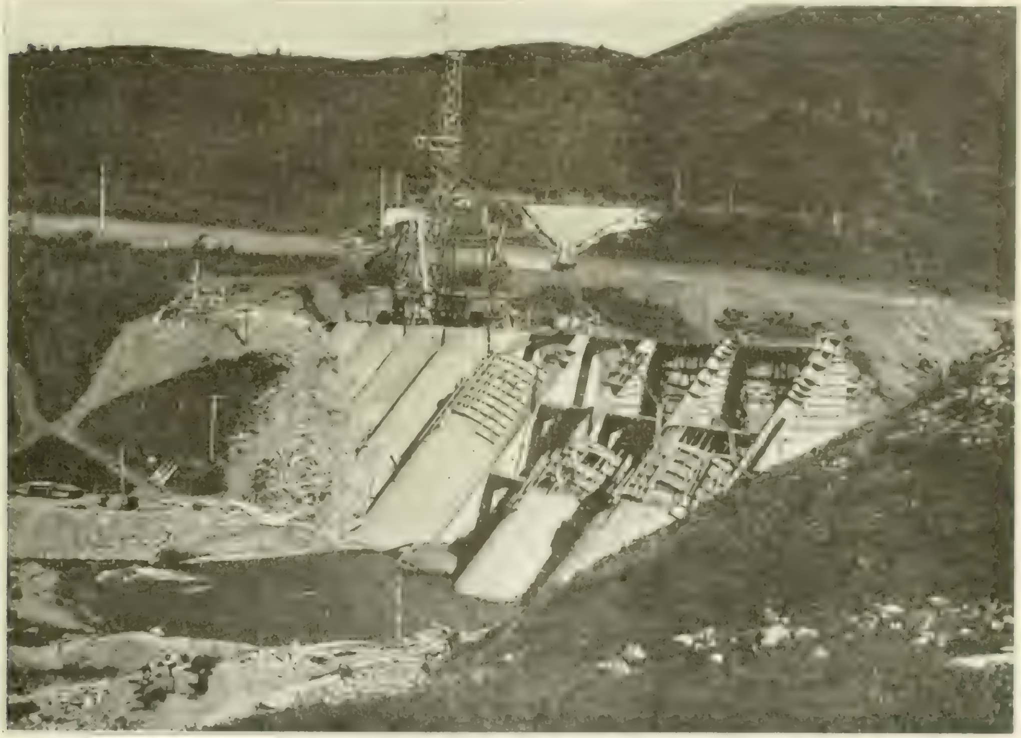
| | 1917-18. | 1916-17. | 1915-16. | 1914-15. |
|---|---|---|---|---|
| Wages | $ 4.86 | $ 4.26 | $ 4.48 | $ 3.57 |
| Chemicals | 10.06 | 7.37 | 5.10 | 4.76 |
| Power | 2.23 | 2.26 | 2.17 | 2.14 |
| House water | .20 | .... | .... | .... |
| Supplies and repairs | 1.49 | .98 | 1.11 | .86 |
| Total | $18.84 | $14.87 | $12.86 | $11.33 |

The Grand Rapids plant was put in operation November, 1912. The method of treatment is lime softening followed by mechanical filtration.

**Women Meter Readers.**—Several water works companies are now employing women to read meters.

# The Mountain Dell Multiple Arch Reinforced Concrete Dam of Salt Lake City

One of the largest multiple arch reinforced concrete dams in the West has recently been placed in service by the city of Salt Lake, Utah. This structure eventually will be 145 ft. high above its rock foundation. At the present time the first unit, bringing the height to 100 ft., has been completed. The dam has been built in Parleys Canyon and forms what is known as the Mountain Dell Reservoir of the city water supply system. At the 100-ft. height it will impound above 300,000,000 gal.



Construction View of Multiple Arch Reinforced Concrete Dam for Water Supply of Salt Lake City, Utah

A view of the dam taken the latter part of June, 1917, is shown in the accompanying illustration. Some of the details of the arch rings and buttresses follow:

Arch rings—
[illegible]
[illegible]
[illegible] 12
Buttresses—
[illegible]
[illegible] ft.
[illegible]

The arch rings are 120° arcs of circles. The horizontal strut tie beams between buttresses are spaced 20 ft. apart vertically and 29 ft. horizontally, beginning at the corbels. The 3,400 cu. yd. of concrete in the tie beams and arches is a 1:2:4 mix; a 1:3:6 mix was used for the 4,900 cu. yd. of concrete in the buttresses.

Sand and gravel were excavated from the foundation site by a slack line outfit and passed through a Dull washer and separator. About 10,000 cu. yd. of aggregate were obtained in this way. The concrete was chuted directly into the forms from a 125-ft. distributing tower. The chutes were supported on a 1¼ cable anchored across the dam and at the top of the tower.

Sectional panel forms 5 ft. square built up of 2x4-in. timbers were used for the buttresses and outside of the arch rings. The inner forms for the rings consisted of trussed liners 8 ft. apart, with vertical 2x4-in. ribs 2 ft. c. to c. around the arch. Two layers of 1½x6-in. sheeting were laid horizontally over the ribs.

The dam was designed by John S. Eastwood, Consulting Engineer for the city. The construction was supervised by Sylvester Q. Cannon, City Engineer. Parrott Bros. Co., Salt Lake City, was the contractor. The total cost of the dam was $90,000.

**One Source of Opposition to Metering.**—It is a matter of common experience, states the Chicago Bureau of Public Efficiency in its report on the water works system of Chicago, that the most strenuous objections to the introduction of meters come from the larger cities. This is due principally to the fact that in such cities there is a larger proportion of tenant consumers, and that the landlords, who in a large number of cases pay the water charges, fear that their bills will be increased by the wasteful and careless practices of their tenants. This fear is not well founded.

# The Deoxygenating Effect of the Effluent from the Miles Acid Process of Sewage Treatment

By F. W. MOHLMAN,
Chemical Engineer, Connecticut State Department of Health.

Experiments with the Miles acid process of sewage treatment were conducted at the New Haven Sewage Experiment Station, under the direction of Prof. C. E. A. Winslow, from June 1, 1917, until May 1, 1918, in comparison with three other processes which have been considered for New Haven conditions. Some very interesting facts were established during this work regarding the Miles acid process.

The Miles patent, No. 1,134,280, claims that the Miles Process "1. Consists in introducing—an inorganic acid as the sole effective agent," and "3. Consists in introducing sulphurous acid into the sewage."

Sulphuric acid seems to have a selective toxic action on bacteria which is more intense than is obtained with the same hydrogen-ion concentration of sulphuric acid. The effect of the sulphurous acid is augmented by the germicidal power of the bisulphites formed from the bicarbonates. Therefore, from the standpoint of effective disinfection, sulphurous acid is preferable to sulphuric. It also has the decided advantage of being cheaper, when made as needed by burning sulphur or pyrites, and conducting the gas into a part of the sewage, which can then be used for acidifying the remaining sewage.

We have applied compressed sulphur dioxide to the sewage as it flowed into a settling tank through a galvanized-iron pipe about 20 ft. long. The settling tank was 16 ft. long, 4 ft. wide and 4 ft. deep. The detention period was 4 hours when treating 10,000 gal. of sewage per day. After acidification the sewage contains bisulphites and some free sulphurous acid. It also contains lime and magnesium soaps, which are attacked by the acid, liberating the free fatty acids. As the sewage passes through the tank part of the bisulphites and sulphurous acid are oxidized to bisulphates and sulphuric acid. The oxidation may easily be followed by determining total $SO_2$ in both bisulphites and sulphurous acid by titration with thiosulphate against an excess of iodine solution.

Preliminary tests made on Feb. 14, 1918, showed a total content of 118 parts per million of sulphur dioxide in the effluent. In order to determine whether this sulphur dioxide would use up the dissolved oxygen in the diluting water if it were discharged into New Haven harbor, various mixtures of the effluent with sea-water from New Haven harbor were made. No especial care was taken to exclude atmospheric oxygen during the mixing. As soon as possible after dilution, dissolved oxygen and sulphur dioxide were determined in the mixtures. The results shown in Table I were obtained.

A great decrease in the dissolved oxygen took place in the dilutions containing 20 per cent or more of the effluent. Further experiments showed that one part of oxygen would be required for four parts of sulphur dioxide in the effluent, according to the reaction $SO_2 + O = SO_3$.

The Miles effluent in our experiments usually contained from 80 to 120 parts per million of sulphur dioxide. The alkalinity of the sewage treated was unusually low, averaging but 50 parts per million, so that a relatively small quantity of sulphur dioxide was required. But even with this small amount of $SO_2$, averaging 100 parts per million, 25 parts per million of dissolved oxygen will be reduced, or in terms of dilutions at summer temperatures, one volume of effluent will immediately reduce all of the oxygen in 3-4 volumes of sea-water. The average sewage would require probably twice as much $SO_2$ as the sewage which we treated, and the effluent would de-aerate twice as much water, or 6-8 volumes. It is not improbable that there might be a distinct zone of de-aerated water at the outfall of the effluent from the Miles process.

In order to determine whether the sulphur dioxide might be oxidized before the effluent is discharged, an aerating tank was constructed by Mr. Harold G. Wynne, of the City Engineer's office, who assisted in the experimental work. This tank, as shown in Fig. 1, consisted of two concrete drain-tiles 30 in. in diameter, placed one above the other, with a filtros plate 1 ft. square cemented into an iron plate at the bottom. Air was blown through this plate from a Nash hydro-turbine, the pressure being measured by a mercury manometer and the volume being measured by a gas-meter.

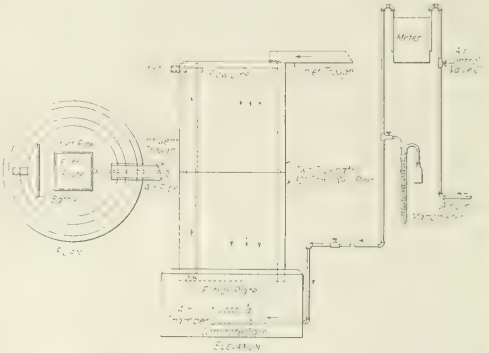


Fig. 1.—Tank Used for Aeration of Effluent from Miles Acid Process.

TABLE I MIXTURE OF SEA-WATER AND MILES EFFLUENT.

| | Effluent. | Sea-water. | 1 Eff. 2 Water. | 1 Eff. 1 Water | 1 Eff 9 Water | 1 Eff. 19 Water. |
|---|---|---|---|---|---|---|
| Dissolved oxygen | 0.8 | 12.0 | 1.0 | 5.0 | 8.8 | 11.0 |
| Sulphur dioxide | 118 | 0 | 8 | 0 | 0 | 0 |

TABLE II AERATION OF MILES EFFLUENT.

Date—March 4, 1918.
Quantity of effluent—220 gallons.
Quantity of air 21.0 cu. ft. at 6.4 inches mercury.
Quantity of free air—25.5 cu. ft.

| Time, minutes. | $SO_2$, parts per mil. | % Reduction air. | Cu. Ft. per Gal. |
|---|---|---|---|
| 0 | 78.1 | .. | .... |
| 10 | 71.7 | 8 | .029 |
| 20 | 53.8 | 31 | .058 |
| 30 | 23.0 | 70 | .087 |
| 40 | 10.2 | 87 | .116 |

Effluent mixed with sea-water, before and after aeration, dissolved oxygen determined immediately.

| Sample. | Dissolved oxygen. Before aeration. | After aeration. |
|---|---|---|
| Effluent | 1.4 | 5.8 |
| Sea-water | 14.2 | .... |
| 1 Effluent: 2 Sea-water | 4.4 | 11.8 |
| 1 Effluent: 1 Sea-water | 7.4 | 11.8 |

TABLE III.—CONTINUOUS AERATION OF MILES EFFLUENT.

| Date. | Sulphur dioxide. Influent. | Effluent. | % Reduction. | Air, cu. ft. per gal. |
|---|---|---|---|---|
| 3- 6-'18 | 99.1 | 44.9 | 54 | .10 |
| 3- 7-'18 | 70.4 | 14.4 | 79 | .10 |
| 3- 8-'18 | 72.3 | 14.4 | 80 | .11 |
| 3- 9-'18 | 69.1 | 5.2 | 92 | .10 |
| 3-10-'18 | 81.3 | 46.4 | 43 | .10 |
| 3-11-'18 | 80.9 | 36.1 | 55 | .06 |
| 3-31-'18 | 53.8 | 10.2 | 81 | .10 |
| 4- 1-'18 | 108.5 | 37.4 | 65 | .10 |
| 4- 2-'18 | 90.9 | 26.5 | 71 | .10 |
| 4- 3-'18 | 71.0 | 19.8 | 72 | .10 |
| 4 -4-'18 | 92.2 | 4.5 | 95 | .10 |
| Average | 78.1 | 23.6 | 70 | .097 |

The tank was used both on the fill-and-draw and continuous plan. When used intermittently, it was filled with effluent and the air started, samples being withdrawn at intervals and analyzed for sulphur dioxide, the quantity of air being measured at the time each sample was withdrawn. Results of an average experiment of this kind are given in Table II.

The results of this experiment have been substantiated by various other experiments on the fill-and-draw plan. The tank was next used as an aerator on the continuous-flow plan. The effluent from the Miles tank was passed through the tank as shown in Fig. 1, having a detention period of 31 minutes. Samples of the influent were taken at 3 and 9 a. m. and p. m., and of the effluent 30 minutes later. The average results of these experiments are shown in Table III.

These results are quite similar to those obtained on the fill-and-draw plan, with 30 minutes' aeration, except that slightly more air is necessary. The close agreement in $SO_2$ content in the effluent is accidental. In each method 70 per cent of the $SO_2$ was removed in 30 minutes' aeration, but with 97,000 cu. ft. of free air per million gallons of effluent when operating continuously, as compared with 87,000 cu. ft. per million gallons on the fill-and-draw plan.

The aerated effluents did not de-aerate the diluting water to an appreciable amount at any time, and thus could be discharged into the harbor with safety. Bacterial counts made by Mr. W. S. Sturges before and after aeration showed that there was practically no change in the bacterial content.

Laboratory experiments in which wood plates were used for diffusing the air indicated that the amount of air required could be reduced considerably by diffusing the air very finely. This experience is similar to that found in the activated-sludge experiments at Milwaukee, but it is probable that this oxidation, which is purely chemical, is even more affected by the fineness of division of the air than is the oxidation in the activated-sludge process, which is biological. The quantities of air used in the experiments with the filtros diffuser were from one-fifteenth to one-twentieth of those used in the aeration with activated sludge, so it is probable that the cost of this aeration would be low. The tank used for the aeration was too shallow to be very efficient, and it is believed that the results obtained in these experiments could be greatly improved by further work. While this aeration will make a Miles plant more complicated, and the process more costly, it does not necessarily condemn the process, as the aeration period is very short and the amounts of air necessary but a small fraction of those required in the activated-sludge process.

**Conclusions.**—1. The Miles acid effluent contains unoxidized sulphur dioxide.

2. This sulphur dioxide is oxidized at the expense of the dissolved oxygen in the water in which the effluent is diluted.

3. The sulphur dioxide may be oxidized before dilution by aeration for a short time with relatively small quantities of air. After this aeration the effluent will not de-aerate large volumes of diluting water.

**No Annual Convention of N. E. W. W. Association.**—Announcement has been made by Willard Kent, secretary of the New England Water Works Association, that owing to conditions caused by the war and for patriotic reasons, the organization will not hold its annual convention this year.

## Maintenance of Drainage Canals

The proper maintenance of drainage canals is second in importance only to the actual construction of the channels. In achieving the desired end of maintaining efficient waterways, it is necessary to remove the willows, cottonwoods and other young sprouts that spring up in and along the channels following soon after the newly made excavation. Suckers growing from stumps along the berms should be cut off. And, in addition, logs, trees, tree-tops, stumps and drift must be taken out of the channel. Where bars form or slides occur, these must be given attention if they are of sufficient size to offer a serious impediment. An interesting description of the maintenance methods employed in the Black Bayou Drainage District is given in a recent issue of the Washington County Drainage Bulletin, from which the notes following are abstracted:

**Removing Growth and Debris.**—In carrying out the work of clearing growth and debris from drainage channels in the Bogue Phalia Drainage District, some of the work has been done under contracts, but the greater part has been done by the force account method, by a crew of men working under the drainage district itself.

The contract work has been done mostly by negroes who lived close to the drainage channels, and who would contract to clear small stretches of ditch near their cabins.

The force account work has been carried out by a crew ordinarily consisting of a foreman, from 10 to 20 negro laborers, and a cook, all working under the direction of the resident engineer. This party lived in tents near the work, moving camp whenever necessary in order to be close to the work under way.

In clearing a ditch, some of the men removed the small drift and pulled willows and sprouts that one man could pull. The remainder of the crew followed behind the others and cut the sprouts that were too large to be pulled. The men kept sufficiently near together so that they could assist one another in removing drift too large for one man to handle. Where trees were in the channel, they usually had to be sawed up into pieces before they could be removed. Willows and small drift have been disposed of by throwing onto the spoil bank. On large channels, where the distance to the spoil bank has been too great for throwing, the debris has been either piled and burned or carried out of the ditch.

For cutting the growth too large to pull, machetes, brush axes and grubbing-hoes are used. The machete has proven the most useful tool that is made for this kind of work. A cross-cut saw, sledge, wedges and axes are used for cutting up trees and large debris so that they may be taken out of the ditch. Cant hooks have been used in handling the heavier logs. In prevention of sore hands among the laborers pulling sprouts, cotton or canvas gloves have been found of material assistance.

The proper time to remove growth is while the sap is up, for if the sprouts are pulled or cut when the sap is down, the pieces of roots broken or cut off below the surface shoot up much more readily the following season. In central Mississippi, the sap is up from about the first of May until the early part of September, and between these months the best results in removing growth have been obtained.

**Chemicals and Pasturing Not Successful.**—Some experimental work has been done in the Bogue Phalia Drainage District on the use of chemical destroyers for killing trees, sprouts and coco grass. In general, the results obtained have not been satisfactory.

The Bogue Phalia Drainage District has also tried the method of keeping down growth along the banks of the Bogue Phalia by pasturing stock within a fenced area. This has not proven a success because a sufficient number of animals could not be kept on the pasture, a condition resulting largely from pasture land being plentiful in this locality in relation to the number of head of stock to be pastured. In a long developed country where pasture land is scarce, a sufficient number of stock can be pastured on each acre of land to keep down the growth successfully, but in a new country—such as the Bogue Phalia District—where stock is less plentiful and pasture land is less scarce, pasturing is not likely to prove successful.

**Bars and Slides.**—On newly constructed work there is always a considerable number of small bars and minor slides in the ditches that are the result of the natural agents of weathering and which constitute deterioration that must be expected with the present most common method of constructing drainage channels by floating dipper dredges. In many cases, these bars and slides are so small that they are not serious from the standpoint of good drainage. Where the fill in the channel assumes some importance, measures must be taken looking to the removal of the bar. The most usual means of removing such bars is by blasting with dynamite. This method has been used during the past 2 years in the Bogue Phalia District.

## The Practicability of Adopting Standards of Quality for Water Supplies

In spite of the fact that the attempt to establish a so-called standard to serve as a basis for interpreting or classifying the quality of potable waters has met with but little success in the past, endeavors are still being made to standardize the consideration of analytical results so as to eliminate personal judgment as a feature of interpretation. The difficulties besetting these efforts, such as the undetermined significance of the bacterial test made by various methods, the importance of varying chemical content and the evidence of sanitary surroundings, are still present in probably a greater degree than in the past, on account of the development of the science of water bio-chemistry and the added confusion created by the ever changing methods, media, temperatures, and differentiations. A very complete discussion of this subject was given by Mr. Robert B. Morse, Chief Engineer, and Mr. Abel Wolman, Division Engineer, Maryland State Department of Health, in a paper presented at the last annual convention of the American Water Works Association. A summary of their conclusions follows:

The establishment of a standard of quality for potable waters means the setting up by some accepted authority of a rule for the measure of quality. Since quality is a variable attribute, intricately dependent upon a series of natural physical, chemical and biological phenomena, its measurement becomes extremely difficult. The quality of a particular water cannot, in most instances, be measured adequately by means of the evaluation of only one of its characteristics. The real consideration or interpretation of the potability of a supply involves a series of mutually active attributes, each of which plays a part of importance in modifying and determining the character of the water. Any scientific and practical standard must include, therefore, a composite of all those features which influence a change in quality. The single utimate unit of measure or the final standard becomes, in this way, an index number of properly weighted individual and fundamental units.

The prime requisites for the establishment of any standard are the existence of those basic units which are to be its components and of universal agreement as to the relative significance of such components. In the field of water supply neither of the two above requirements has been fully met. Basic or fundamental units for measurement of quality have not been established with any degree of exactness or accuracy. A unit of measure, such as the B. coli content, certainly cannot be predicated upon such variable procedures as are now followed, without resulting in a confusion of interpretation. The establishment of any unit demands an absolute consistency in its measurement. It is this consistency of measurement which is now absent in practically every available measure of quality.

If inconsistency reigns in the determination of the fundamental units, such as the total count, the B. coli content, the chemical constituents and the sanitary survey, then the general standard of quality, a derived unit composed of basic measures, becomes extremely little value. If we add to this consideration of inconsistent method of obtaining individual units the fact that their relative significance is still unsettled, then a general standard becomes practically useless and even misleading.

The study of the method of evaluating a unit must of necessity antedate the attempt to establish limiting values of such a unit. A critical survey of past standards of quality seems to indicate an assumption that the method of unit-evaluation is fixed, and therefore that limiting values are the desiderata. It is not felt that the status of laboratory or field method of analytical examination warrants any such assumption. The field for future standardization of quality of water supplies would appear to lie more immediately in the consideration of such problems as the relative significance of different bacterial counts, the methods of obtaining the counts, the necessary frequency of sampling, of plating, of numbers of fermentation tubes, the numerical interpretation of usual fermentation tube results, the allowable variations from specified bacterial contents, the determination of real bacterial indices to sewage pollution, the importance of chemical determinations, and the standardization of field survey method. More remotely, the problem of standards is concerned with the coordination of the results of such studies as the above in such a way as to construct a composite unit of measure. Until these studies have been made and a general agreement reached, a standard would have but little value.

**Pitometer Survey at Ottawa Discloses 3,000,000-Gal. Leakage.**—A pitometer survey made last year on a portion of the distribution system of Ottawa, Ont., located leakage amounting to 2,500,000 to 3,000,000 Imp. gal. per day, according to the last annual report of the Works Commissioner of the city. The average pumpage per day was 20,938,000 gal. and the average per capita consumption was 206.1 gal. The largest leak detected was on an 8-in. main; this was wasting 1,000,000 Imp. gal. per day. Another leak on a river section of an 8-in. main was wasting about 450,000 Imp. gal. per day. One valve of an 8-in. main was found to be causing a loss of over 100,000 gal. per day.

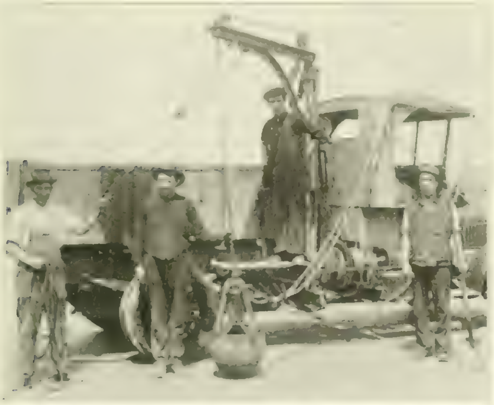
## Catch Basin Cleaning in Cambridge, Mass., with Orange Peel Bucket

By L. M. HASTINGS, City Engineer.

One of the most important items in the maintenance of a combined sewer system—at least so far as cost goes—is the removal from the catch basins of the material which so rapidly collects in them. The common way of doing this work in the past has been to use hand labor to excavate and load the material from the catch basins into horse carts by which it was transported to the most convenient dumping place.

The increasing cost of labor, teams, etc., together with the difficulty of finding dumping places for the material excavated except at remote locations with lengthened haul, has in Cambridge led to an effort to find some means of reducing the cost both of excavating and transportation.

The mechanical appliance which seemed best adapted for the conditions found in Cambridge was one that used an orange peel bucket for excavating and loading the material into an auto truck by which it is transported to the dump.



Catch Basin Cleaning Appliance of Cambridge, Mass.

The machine as finally constructed is quite similar to that built and used by the Public Works Department of the city of Pawtucket, R. I.

A 3½-ton Federal truck equipped with a steel body of special design, and a Wood power dumping hoist was purchased, and the excavating and loading machinery was made in a local machine shop from drawings prepared in the City Engineering Department.

The excavating bucket is made to open and close by compressed air obtained from an Imperial Type 12 Ingersoll-Rand Co. air compressor mounted on the left-hand side of the truck chassis on two 6-in. steel I-beams attached transversely to the frame.

The power to drive the air compressor is obtained from the truck engine from a sprocket on the main propeller shaft which by a chain to the left, drives another sprocket on the shaft of the compressor with a speed of about 500 revolutions per minute.

The air from the compressor is led to the cylinder of the bucket by two ⅜-in. hose lines, and is controlled by a foot valve or "controller" operated by the chauffeur at the platform. This opens and closes the bucket at will.

The bucket is raised or lowered by a simple arrangement of driving gears, clutch driven, and brake, all operated from the platform. Power is obtained from another sprocket on the propeller shaft driving to the right. Both driving sprockets are controlled by a single clutch operated by a lever, so that unless the clutch is engaged, the entire excavating machinery is idle, although the truck itself may be running.

This outfit cost about $6,000 and it has been doing excellent work under the rather trying conditions found here. Many of the basins contain not only the usual mud, sand, water, etc., but often a great quantity of miscellaneous articles which are difficult to remove by ordinary appliances. For this condition the bucket type of machine is particularly well adapted. With this machine the cost of excavation and transporting this material has been substantially reduced, especially where the haul is long and the work is being done in a more satisfactory and cleanly manner than by the old method.

## Thawing Hydrants with Exhaust from Fire Truck

The exhaust from a fire truck was employed during the past winter by the Water Department of Middletown, Conn., for thawing fire hydrants. The exhaust muffler was removed from the 30-HP. 4-cylinder Federal fire truck and the ends used as companion flanges for fastening a 12-in. piece of 2-in. galvanized pipe to the end of the cast iron exhaust pipe. The 12-in. section was connected by a union and elbow to another piece of 2-in. galvanized iron pipe, 4 ft. long. To this latter a piece of ⅜-in. hose 7 ft. long was connected by a special coupling. In the thawing operation the end of the hose was forced down the barrel of the hydrant until it came in contact with the ice. The engine was then started and the hot exhaust carried to the frozen parts of the hydrant. The hydrants usually were thawed out in 3 to 4 minutes; in one case, however, it took 18 minutes.

**Undeveloped Water Power of United States.**—In a report prepared for the water power committee of the U. S. Chamber of Commerce, Mr. Calvert Townley states that it has been estimated by a careful engineer that in 1911 there were over 26,000,000 steam engine horsepower capacity in use (including railroad locomotives) in the United States. The aggregate water horse-power developed and undeveloped has been computed as around 60,000,000. Of this latter the United States census of 1912 gives 4,870,000 as developed, and in a report of January, 1916, the Secretary of Agriculture estimates this total to have been increased to 6,500,000. Making liberal allowances for correction in these several figures, it seems probable that there are in service from four to five times as many steam as water horsepower and that there are still undeveloped water horsepower equal to at least twice that of all the steam capacity in service. Some of the undeveloped power sites are too remote from any market to be now utilized, and an uncertain number are not commercial prospects; but even so, it is clear that the possibilities of additional development are very great.

**Portable Pipe Tripod.**—One waterworks superintendent has improved his pipe tripod by replacing the windlass crank with two buggy wheels. As a result he can lower the pipe as little as desired without jar or jerk, and when the outfit is to be moved it can be rolled along on the wheels.

# Border Method of Irrigation for Porous Soils

Border irrigation on properly prepared land enables the irrigator to make light applications of water with comparative ease. The irrigating can be done quickly without waste of water and labor. Crop production is increased by maintaining a uniform and optimum amount of water in the soil, which is possible by this method of procedure. Border irrigation is stated to be the best known means of applying water to soils of an open porous, sandy or gravelly nature. Useful suggestions on this method of irrigation are given by Mr. R. W. Allen, Superintendent Umatilla Branch Experiment Station in a circular of the Oregon Agricultural College Experiment Station, from which the matter in this article is abstracted.

The border method of irrigation consists in applying water to the land by means of sloping checks. These checks are made level in cross section and slope lengthwise, usually with the natural and major slope of the land.

The width, length and shape of the borders should depend upon the character of the soil, slope of land, and the size of the head of irrigation water available. On coarse soil they need to be small so as to be quickly covered to prevent waste of water by deep percolation. On shallow soil they should be made small enough to irrigate quickly, in order to prevent excessive irrigation and the consequent complications of a waterlogged soil, or seepage spots in the field. On land with lateral slope they need to be narrow to prevent having steep inclines or dikes between borders. On steep land they need to be narrow and short so as to be irrigated with rather small streams (part of the available irrigation head); as in this way washing of the soil is less liable to occur. Where a large head of water is available and the land fairly smooth, the borders can be wide and long.

The length of borders should range from 70 ft. on very coarse or steep soil to 300 ft. on moderately sloping land of fine texture and good depth. The average length of borders should be about 200 ft. The width ranges from 20 to 40 ft.

On land having rough topography the borders can be made with a minimum of expense in grading by making them in a variety of shapes to conform to the slope of the land, V-shaped, fan-shaped, and L-shaped or crescent-shaped borders are not uncommon.

When borders are properly made the work of irrigating a field becomes very simple. After the stream is started in at the end of a border it remains only to observe its progress and turn it into the next one as soon as sufficient water has passed onto the first border to flow entirely across it. The point to which the water should progress before being turned off will be learned after one or two irrigations. In this way run-offs at the ends can be prevented, and no time is lost in searching for unirrigated portions of the field. Unless the borders are properly made this method of irrigating will not give complete satisfaction.

When furrow irrigation is used it is necessary to make numerous adjustments of the water entering the furrows, and frequent trips to the lower ends of the field to find if all the streams have got through. Much waste of time occurs in doing this, and loss of water results from deep percolation and run-off while waiting for the slow streams to get to the end of the furrows. Land started by furrows is later irrigated by wild flooding, in which the side slope of the field causes the water to crowd to the side, filling low places and skipping the high ones. This results in waste of water, in depressions, and waste of time in trying to get the high places irrigated.

Where flat checks are used the depth of water necessary at the turnout to force the stream across, causes heavy losses of water near the turnout and a great waste results. They should not be used at all on porous soils.

The border system of irrigation can be successfully employed on soils of a very porous character, except those that are steep and subject to washing. Where the grade is more than 8 ft. per 100 on sandy soil they do not appear to be practical, on account of washing, and the difficulty in keeping the water spread out. Unless precautions are taken to have the land well protected by a heavy growth of rye, severe washing and consequent difficulty will be met with in starting alfalfa on land in borders that has as great a fall as 4 to 6 ft. per 100.

**Preparation of Land for Border Irrigation.**—Spring and summer work should be restricted to very limited areas, unless ample covering material is available, on account of damage from the wind. Extensive clearing can best be undertaken from Aug. 1 until winter, as the winter growth of rye on such land is usually sufficient to prevent erosion by the spring winds that usually are severe.

Land is cleared by sagebrush to advantage by hand grubbing, by use of the sagebrush rail, or by the brush cutter. After removing the brush, the rough places should be removed by a Fresno scraper and float. At this stage the field irrigation laterals should be laid out, and the lands staked off to begin preparing the borders.

If the land slopes but one way, the borders can be made rectangular in shape and of uniform size. If it is uneven stakes should be set on the line of two or three contours across the field at the interval it is desired to establish the width of the borders. In this way the ridges separating the borders are carried down the slope of the field in such a manner as to make the land between them level in cross section. It then becomes necessary to throw up the ridges by use of a plow or scraper. A small amount of grading and the use of the float are then necessary to take out irregularities in the ground surface within each border.

In leveling land that has a uniform slope the location of the borders can be staked out first and marked by plow furrows. The scraper (fresno or buck scraper) should then be run back and forth across the field, taking soil from the high places in each border and depositing the soil where the ground is low, at the same time leaving soil in the rows of stakes for the bank or levees separating the borders.

Where it is planned to have borders as long as 300 ft. the land should be prepared with a temporary ditch running through the center, so that the water will not have to be run over 150 ft. while the crop is young. When the crop is well established the temporary ditch can be removed and the water run over the long borders if it has been found that the available irrigation head is large enough to irrigate long borders economically.

The levees, when made, should be about 18 in. to 2 ft. wide and 1 to 1½ ft. high. As soon as the land is graded it should be irrigated to settle all loose places and to determine how the water flows over it. While water is on the borders it is a good practice to get in with whatever implements are necessary and do all the work needed to make the water flow perfectly. Working this character of soil wet does it little, if any, damage.

As soon as the land is properly leveled for irrigation precaution should be taken against wind erosion. It should be covered lightly with straw, about ½ to 1 ton an acre, and sown to rye at the rate of 20 to 40 lb. an acre. Where the soil is very sandy and subject to serious erosion, and when irrigation water is not available with which to insure rapid growth of the rye, extra care should be used to prevent erosion.

The straw should be made fast to the ground by running over it with a disk harrow set straight to bury part and leave the remainder standing in the air. This serves as a windbreak by reducing the velocity of the wind at the surface of the land. Coarse manure or fine brush can be used to advantage instead of straw.

This treatment prevents, in a measure, erosion by irrigation water. After the rye gets a foothold, it is very effective in preventing erosion by either water or wind. It stands much punishment and is the best available crop to use to protect land from erosion.

Alfalfa should be sown at the rate of 12 to 15 lb. an acre with a drill. The use of a drill is necessary with alfalfa, as with all other crops sown in light soil, to insure getting the seed down to a uniform depth so that it can be kept moist enough for germination and growth to take place. Set the drill to run from 1 to 3 in. deep, depending on whether the land is easy or difficult to keep moist. The drill should always be driven at right angles to the direction of the flow of water on the land, in order that washing will not occur between the rows of plants while the land is yet soft.

Unless land is sufficiently protected by the nurse crop to prevent washing, when a large head of water is turned into the borders it should be irrigated once or twice by means of furrows. When the land is well protected, however, flooding within the borders, even from the beginning, requires much less time and water and is more effective, than furrow irrigation. After the first or second irrigation, flooding is safe for the less-protected lands.

The small flood boxes and lath boxes necessary for this first irrigation can be taken up and used numerous times during the period usually required to get a farm reclaimed.

**Typhoid Fever Eliminated at Traverse City, Mich.**—The practically total elimination of typhoid fever at Traverse City, Mich., is credited by the local health officer to the co-operation on the part of the city Water Department officials, combined with the treatment of the drinking water supply since 1915 with liquid chlorine.

**Cement Joints for Cast Iron Water Mains.**—Cement joints in the cast iron water mains at Redlands, Cal., have given perfect satisfaction, according to Geo. S. Hinckley, City Engineer, and have proved much more economical to make than lead ones. The joints of all the cast iron water pipe in this city are made of cement.

**Moving Coal with Wheel Scrapers.**—A 1½-yd. wheel scraper of the type employed in grading work, is used by a St. Louis company in transferring coal from storage piles to its boiler room. By this means the work formerly accomplished by 6 or 8 men with wheelbarrows is now done with one man and a horse.

# Location Methods for Water Works Distribution System in Newton, Mass.

By EDWIN H. ROGERS,

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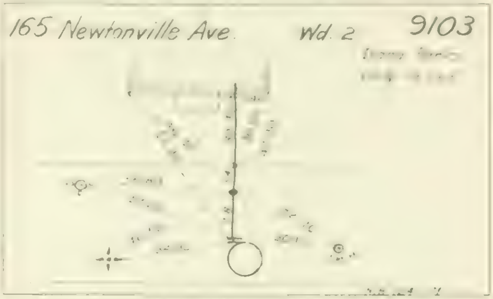
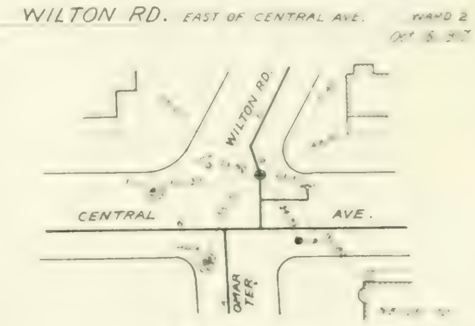
The city of Newton, Mass. (population 45,000), has 163 miles of water mains 4 in. to 20 in. in diameter, 111 miles of service pipes, about 1,100 post hydrants and 4,100 gate valves.

All engineering work and the recording of the location of mains, services, etc., for the water department are performed by the city engineering department. The mains, gate valves and hydrants of the general distributing system are shown on a single plan on a scale of 600 ft. to the inch. A large proportion of the water mains, amounting to about 130 miles, are also shown on detail plans of individual streets on a scale of 40 ft. to the inch. These plans show the abutting houses with their service pipe connections, gate valves and hydrants, and also other underground structures such as sewers and drains, underground electric conduits and gas mains, and serve as plans for sewer assessments.



Service Location Card

All extensions of mains are staked out for line. The grade is not usually given except in special cases, the mains being customarily laid at a depth of 5 ft. from the surface of the ground to the center of the pipe. Records are kept of ledge excavation done in laying the mains and after the work is completed the branches, blowoffs, hydrant connections, gate valves, etc., are located. Service pipes are located after laying, tie measurements being taken from the house



Gate Location Card

which they serve and from other prominent objects to the corporation at the main and to the shutoff box on the surface, and the length of the service is measured from the corporation to the shutoff, shutoff to the street line, and from the street line to the house. In laying the service, the workmen leave a stake in the street over the corporation so that it can be located at a convenient time.

The shutoff box is placed in the grass border between the sidewalk and the gutter or else in the sidewalk near the curbing. A shutoff is also provided at the corporation, but is accessible only when the street is dug up.

All measurements and records are taken in notebooks kept in the office of the engineering department. In the case of services, copies of the tie measurements are made on a standard 3-in. x 5-in. index card and kept on file at the water works yard. A typical service location card is shown herewith.

Every such service card gives the street and number of the service, thus enabling them to be easily classified. The ward is also given as this is of use in the case of duplicate street names, of which we have quite a number. Each service is consecutively numbered and indicated on the card. The owner's name is also given, together with the date of the location and a reference to the note-book.

All of our hydrants are post hydrants and visible at all times except when they may occasionally be covered by drifting snow.

The gate valves are located so far as possible by measurements from houses, trees, poles, or other prominent objects which are always apparent when the ground is covered with snow, which in this city is likely to occur on occasion to a depth of a foot or more. These measurements are all kept in note-books and subsequently a plan on tracing cloth is made to scale if possible, traced from our 40 ft. scale plans, showing the layout of the mains in the vicinity of the gate and the tie measurements to the gate. These tracings are 4 in. x 6 in. in size and blue-prints are taken from them on heavy paper for the use of the water works employes. A typical gate location is illustrated. For indexing purposes, these plans show at the top the name of the street on which the gate is located, its direction from the nearest cross street, and the ward, date of location and note-book reference also shown.

The card index method of location of services and gate valves has proven very satisfactory as the cards may readily be taken from the files to be used by the workmen on the streets, and if lost or defaced are easily replaced from the original notes.

## Ram Swung from Tripod for Driving Wood Pipe Into Place

A 200-lb. ram swung by block and tackle from a tripod made of 2-in. pipe facilitated the laying of 18-in. machine banded wood pipe for the recently completed Lindsay-Strathmore irrigation project in California. The ram was used to drive the pipe into place. With this device a gang of 5 men and foreman completed in the trench an average of 1,100 to 1,200 ft. per 9-hour day. The pipe was in 12-ft. lengths and had slip joints fitting into couplings. The above average is about the rate of progress when the pipe is driven home by means of sledges. However, the tripod and ram made the work much easier for the men.

## Special Cast Iron Lining of Two Large Bore Wells*

By W. H. MAXWELL,
Borough and Water Engineer, Tunbridge, Wells, England.

Economical water supplies are frequently obtainable for public purposes by sinking borings in districts where the geological formation is favorable and by these means the writer has recently procured a supplementary supply in his district from two new large-diameter bore wells, which have proved capable of yielding 60,000 gal. per hour.

**Water-bearing Strata.**—This supply is derived from beds known geographically as Ashdown sand rock of the Hastings series, which, at the site of the borings in question, is reached after passing through 185 ft. of Wadhurst clay. The depth of boring into the sand rock is 151 ft., portions of which proved to be well fissured, whilst other parts were found solid and compact. The layers of this rock are separated by many beds of pale yellow clay. The progress of boring was sometimes slow, owing to the hardness of the rock, and, in the course of the work, the greatest depth of continuous solid rock was 20 ft.

The superincumbent clay in its natural state is a hard impervious mass, but, after contact with water, becomes softened into a treacherous and uncertain material, requiring immediate lateral support by means of the permanent metal linings of the borings.

**Cast Iron Lining Tubes.**—The boring and lining operations were carried on under water throughout the work. This in the earlier stages of the work, was derived from points near the surface, and had, therefore, later on, to be completely excluded, being unsuited for purposes of public supply.

The natural water from the Ashdown sand rock is of a corrosive nature, and acts detrimentally upon some classes of metal immersed in the wells for long periods on account of its chemical composition. The action is due to the presence of salts which, although themselves neutral, may act as electrolytes, producing galvanic activity between dissimilar metals, or between dissimilar parts of the same metal.

From previous experience it was proved that the usual mild steel screwed and socketed lining tubes were not sufficiently resistive for the conditions described, the metal being eroded into holes in the course of a few years. After a prolonged investigation with metallurgical tests and laboratory experiments conducted by Mr. Bertram Blount, chemist, etc., of Westminster, it was finally decided to adopt cast iron tubes, 1¼-in. thickness, as the most suitable lining material. Practical experience extending over many years had also shown that cast iron was not perceptibly affected by the water, provided no machine or bright face was exposed to its prolonged action.

The metal used in the lining tubes was required to be of such a composition and texture as would render it highly resistive to attack by the water, and was of a tough, uniform, dense, and close-grained character. Irregularity of composition was avoided as far as possible.

The over-all diameter of the borings through the clay is 39 in., and the tubes lining same were made from a mixture of strong grey cast iron, sufficiently tough to allow of the castings being readily drilled and tapped with a clean and strong thread. The metal used was not permitted to be from first runnings, but was re-melted in the cupola or air furnace. All sharp angles in the castings were avoided, so as to reduce the liability of cutting through the protective "coatings," subsequently applied.

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*From "Water and Engineering," London, England

The tubes were cast vertically in 12-ft. lengths, in dry sand moulds, and in accurately faced and truly jointed boxes, without the use of core nails, chaplets, thickness pieces, or any similar substitutes. An ample "head" of metal was insisted upon to ensure through soundness throughout, the head being afterwards cut off in a lathe. The whole column of tubes lining the borings, weighing about 40 tons in the case of the largest diameter, had to be suspended in the boring, jointed at the ground surface, and lowered gradually as the work of sinking proceeded. After lowering a sufficient depth, additional tubes were added to the top of the hanging column, so that it was essential the machined ends and joining-up sleeves should fit accurately and without difficulty or delay.

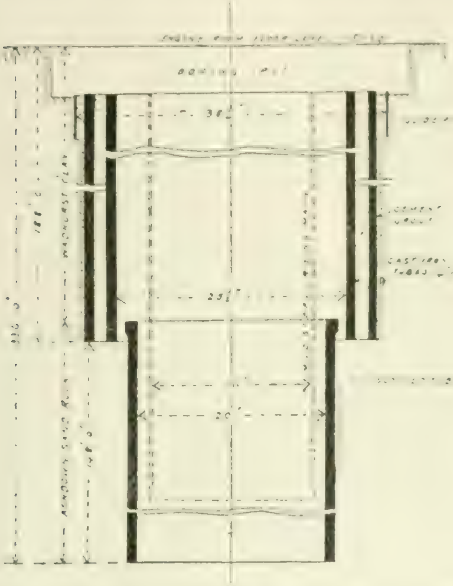

Fig. 1.—Section of Bore Wells, Showing Method of Lining.

During manufacture, the tubes were regularly inspected at the foundry from time to time as made, and were tested for quality of metal, and carefully examined to see that they were truly cast, straight, perfectly cylindrical, and of uniform thickness. The ends of the tubes were afterwards accurately machined down circumferentially to templates in a lathe, and fitted with mild steel sleeves or sockets for the purpose of forming the joints between the various lengths of tubes.

The linings through the clay (Fig. 1) consisted of two rings of cast iron. Through the Ashdown sand rock one ring of cast iron perforated tubes was used, as this rock and the intermediate clay beds were not sufficiently stable to stand permanently without lining.

**Portland Cement Grouting.**—The space, $2\frac{1}{8}$ in. in width, between the two concentric rings of cast iron passing through the clay was filled with Portland cement grout, in order that, should the inner cast iron ring deteriorate after many years, there would remain a continuous ring of cement to protect the outer cast iron lining.

Portland cement grout was also placed at the back of the outer cast iron tubes to fill up the space and cavities formed by slips in the clay between this lining and the natural ground, thereby giving additional protection, and also excluding infiltration of impure surface water. The grout was mixed to a thick creamy consistency, and all passed through a fine wire netting sieve of about $\frac{1}{8}$-in. mesh, in order to remove all lumpy or unmixed particles. In the case of the first borehole, the cement grout was simply poured into the tops of the annular spaces to be filled, and the water thus forced out. The grouting was continued in this way until all spaces were full, and the thick grout appeared at the tops of the tubes.

A different method of grouting was adopted in the case of the second boring, in order to check the quantity of cement used, and also to confirm the assumption that the spaces had been solidly filled. The dimensions of both borings are exactly similar, so that the quantities of grout used should also be identical. In this case a 1-in. diameter galvanized iron pipe was passed down the annular space for the purpose of conveying the grout down to the bottom of the cavity to be filled. This pipe was supplied with grout from a Greathead grouting machine, and forced down by compressed air. After discharging the contents of the grouting cylinder the 1-in. pipe was raised in the annular space by a previously determined amount, so as just to reach the surface of the last deposit of grout.

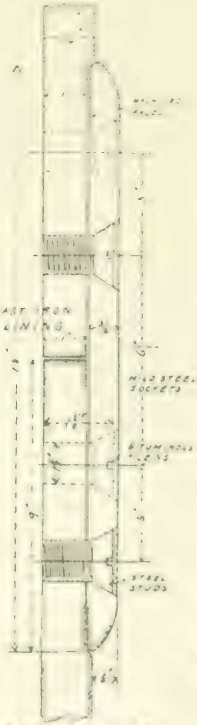

Fig. 2.—Detail of Joint in Lining Tubes and Sleeves

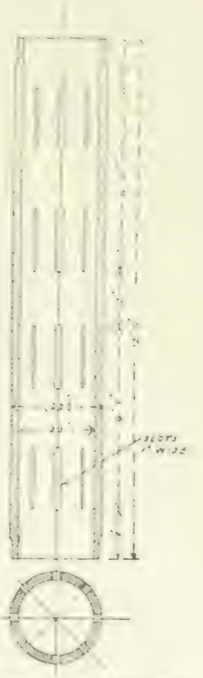

Fig. 3.—Cast Iron Slotted Tubes

This process was continued until the space was quite full. A comparison of the weight of cement used in this case with that used in the first-named boring showed it to be identical in weight within a very trifling amount, from which it was concluded that the annular spaces throughout their depth had both been solidly filled. All grouting operations once started were continued day and night, if necessary, without intermission.

**Manufacture and Handling of the Lining Tubes.**—The whole of the tubes and their accompanying sockets were carefully fitted and marked at the maker's works before despatch, so as to ensure accuracy and ease of fitting on the site of the bore wells. The tubes were numbered consecutively throughout for purposes of record and for convenient handling. At the site of the bore wells, the tubes were stored in the order they ultimately occupied in the wells, in order to minimize labor of handling and probable consequent damage to their surfaces and coatings.

Every precaution was taken to avoid breaking through the foundry skin of the metal, and any small projections or ridges on the surfaces of the tubes were passed undisturbed, without fettling or dressing off, so as not to expose the bright metal to the action of the water. With the same object in view, the machined ends of the tubes and faces of sockets were thoroughly well covered with hot bituminous coating during the process of jointing up the tubes.

All tubes were tested at the foundry before "coating," in the presence of the engineers' representative, by hydraulic pressure to 200 lb. to the square inch. This pressure was maintained for a period of from 5 to 10 minutes, and during the test the tubes were smartly struck all over with a 2½-lb. hammer. After satisfactorily passing this test, each tube was stamped with the engineers' private mark.

The specification required the manufacturer to furnish from each running two test pieces of the metal to be actually used in casting the tubes, and the deflection test was specified as follows: "A bar, 1 in. wide, 2 in. deep, and 3 ft. 6 in. long, when supported on edge on bearings 3 ft. apart, shall sustain a load of 30 cwt., applied at the center, with a deflection of not less than ⅜ in. The bar shall be tested to destruction." All tubes rejected by the engineer were required to be broken up in the presence of his representative.

**Method of Jointing the Cast Iron Tubes.**—The largest size of cast iron tube was 32¼ in. inside diameter by 12 ft. long, and the metal was 1¼ in. in thickness. Each pipe of this size weighed approximately 2¼ tons. The ends of the 12-ft. tubes were machined down, at the foundry, for a length of 9 in. from 1¼ in. in thickness to 1 in. thick (Fig. 2) so as to minimize the projection of the mild steel sleeves, and to reduce friction against the sides of the borings during the lowering of the tubes into position. The butt ends of the tubes were also machined true and square to the center line, and the joints between the differest lengths were made by means of mild steel sleeves 18 in. long by ¾ in. thickness of metal, tapered at the top and bottom ends to minimize surface friction. The sleeves and machined ends made a first-class close-fitting joint, which was secured by mild steel studs 1⅛ in. in diameter, spaced according to the load to be carried. The number of the studs varied according to the weight of the tubes to be suspended. The studs and all surfaces of sleeves and tubes were covered with hot bituminous material while being put together. The joints in the 12-in. tubes for the inner and outer linings were staggered by starting with a 6-ft. length of outside lining and a 12-ft. length of inside lining. The tubes for the inner cast iron lining had four lugs cast of the outer circumference near the bottom of each pipe to keep the linings concentric. The double cast iron lining was sunk 3 ft. into the rock to a total depth of 188 ft. so as to overlap the 20-in. perforated tubes.

At the tops of the borings guide tubes were fixed for a depth of 30 ft. These consisted of lap-welded mild steel pipes, 38⅜ in. internal diameter, of metal ¼ in. thick, formed in two 15-ft. lengths, and joined into one pipe 30-ft. long by means of external welded circumferential butt straps, single riveted on.

**Slotted Tubes in Water Bearing Strata.**—The perforated or slotted tubes (Fig. 3) lining the Ashdown sand rock, which forms the water-bearing strata, are of the same thickness of metal and are jointed similarly to slotted tubes referred to above. Wherever the 12-in. slots or perforations came opposite soft clay beds occurring in the Ashdown sand, the slots were filled with Portland cement before placing the pipes in position, in order to shut out, as far as possible, any friable material likely to fall off the sides of the borings into the insides of the tubes. Careful measurements taken during the sinking of the bore wells by means of the boring rods of the positions and depths of the strata bored through.

**Bituminous Coating for Tubes.**—The cast iron tubes, immediately on being turned out from the foundry, were subjected to an hydraulic pressure test. Those proving satisfactory were at once machined at the ends and afterward coated as soon as possible to avoid rust.

Having been cleaned free from mould, sand, etc., the tubes were then fully immersed in a bath of clean hot water at full boiling temperature, to remove carbon, dirt, or other foreign substances, and were not removed from the bath till they had acquired the temperature of the water. After removal from this hot water bath, the tubes were separately wholly immersed vertically in a hot solution of the bituminous coating prepared according to the Dr. Angus Smith process at a temperature of from 300 to 350° F. The pipes remained in this solution for some minutes, and were then gradually withdrawn and allowed to drain off by suspending them in a vertical position. The coating fumed freely, and set hard within an hour. In order to avoid pin holes, and to render the coatings more uniform, the tubes were twice dipped as above described. The bituminous mixture consisted of a refined coal tar, pitch, linseed oil, and resin, heated in a suitable furnace, and the whole process resulted in a good, firm, durable coat upon all castings used. Similar bituminous coatings were applied hot at the site of the works to the joints, whilst putting the tubes together ready for lowering into the borings.

Previous to despatch by rail, the tubes were all packed with soft material, so as to prevent damage to the coatings in transit. All bright machined parts were also coated, but this coating had to be cleared off immediately before joining up the tubes, in order to permit of the spigot ends entering the mild steel sleeves. A fresh hot coating was then applied, and the tube slipped home into its final position in the sleeve. The studs, after immersion in the bituminous composition, were then inserted.

**Sinking of Lining Tubes After Placing in Borings.** A short time after the 20-in. perforated tubes took their full bearing upon the bottoms of the borings, these tubes, owing to their considerable weight, and to the gradual softening of the strata due to the access of water thereto, commenced sinking. This trouble, if not arrested, would soon have had the effect of losing the recessed cap provided at the top of the 20-in. perforated tubes. During boring operations it was found that the principal water-bearing fissures occurred some distance up from the bottoms of the borings, and, in view of this, in order to arrest the further settlement of the 20-in. tubes, a Portland cement grout plug, about 7 ft. in length, was placed at the bottoms of the two bores at a depth of 336 ft. from the surface. When these plugs had become properly set, the sinkage of the cast iron linings completely stopped. In the event of it being desired at any future date to sink the borings deeper, these cement plugs could readily be bored through with a smaller diameter hole.

## Operating Rules for Small Sewage Treatment Plants

In a paper presented last spring before the Iowa Engineering Society, J. H. Dunlap, Associate Professor of Hydraulics and Sanitary Engineering at the State University of Iowa, suggested that the State Board of Health should prepare directions for the operation of certain sewage treatment plants, representative of general types. One plant, of course, differs from another, even of the same type, to such an extent that no one set of directions would apply generally. In order to illustrate what might be done in one particular case, Prof. Dunlap gave the following directions as applying to the operation of the plant at the State Hospital and Colony for Epileptics at Woodward, Ia.:

### Daily.

1. Visit the plant.
2. Give every part of the plant careful inspection.
3. Record the amount of sewage flow.
4. Fill out the report blank for the day.

### Weekly.

1. Take samples of raw sewage and of tank effluent in the Imhoff conical glasses, and find the per cent removal of solids after 2 hours' settling. It should average 95 per cent.
2. Break up the scum in the gas vents with the hose.
3. Measure and record the depth of sludge in the sludge chamber.
4. Clean the inflow channels and the inlet and outlet weirs.
5. Skin the sedimentation chamber.
6. Squeegee the side walls, aprons and slot. (This may have to be done more or less frequently.)
7. Take a sample of the filter effluent for the methylene blue test for relative stability. When kept at a temperature of 68° F., the blue color should be retained for at least 10 days.
8. Operate all valves.
9. Turn water through the sludge grids for one minute.
10. Fill out report blank to date.

### Never.

1. Never fill the tank with sewage when empty. Use water.
2. Never unnecessarily agitate the contents of the sedimentation chamber.
3. Never by-pass sewage either at the inlet or from the siphon chamber without recording the reason, date and duration, and notifying the State Board of Health within 24 hours.
4. Never run out large amounts of sludge at a time; better, small amounts every 2 to 6 weeks.
5. Never withdraw all the ripened sludge. Some should be left to seed the tank.
6. Never fill the sludge bed to a depth of more than 18 in.
7. Never allow the sludge in the sludge chamber to rise closer to the slot than 2 ft.
8. Never stir the surface of the sand filters to a depth greater than ½ in.
9. Never allow the filter beds to stand flooded.
10. Never by-pass sewage directly to the underdrains by digging holes through the sand.
11. Never allow weeds and grass to clog the surface of the filters.
12. Never add new sand which has not been approved by the State Board of Health.

### Always.

1. Always recollect that the business of this plant is to transform the organic matter in the sewage so that the final filter effluent will be clear and nonputrescible.
2. Always keep in mind that only about ⅓ of the total organic matter settles out in the Imhoff tank.
3. Always remember that the remaining ⅔ must be oxidized by bacterial action in the sludge beds into harmless mineral compounds.
4. Always back-fill the sludge pipe with water, and flush out the pipe running to the sludge bed, after withdrawing sludge.
5. Always clean the surface of the sludge bed before applying a new dose, and add more top sand if necessary.
6. Always make sure that there is enough room in the sludge chamber for the winter sludge.
7. Always note the distribution of sewage over the filters, and if uneven, correct it by re-leveling the beds or re-baffling the distributors.
8. Always keep the filter surface open by raking or harrowing to a depth not greater than ½ in. When this fails to prevent ponding, remove the upper ½ in. of sand and surface mat. Not more than 1 in. of sand should be removed in one year.
9. Always give the beds a thorough overhauling in the late fall just before freezing weather. Pile up the dirty sand in small piles 6 to 8 in. high and 3 to 6 ft. apart. These piles will help support the ice.
10. Always watch for warm days in winter, when the surface of the filters may be put into good condition.

**Three-Year Courses in Engineering and Ship Construction at Lehigh.**—Dr. H. S. Drinker, President of Lehigh University, reports that there has been a very large number of applicants for admission to the University's 3-year war courses entitling graduates to degrees in engineering and arts and science. He points out that, while these new courses cover the full schedules formerly given in four years, sufficient vacation time is nevertheless afforded. The Lehigh University 3-year course in Ship Construction and Marine Transportation, to be started in September, will be under the direction of Prof. F. P. McKibben, head of the Department of Civil Engineering. The new course will be a combination of engineering and economics to prepare students for ship construction during the war and, in addition, foreign commerce after the war.

# Effect of War Conditions Upon Construction, Operation and Maintenance of Water Works

Water works construction labor has greatly increased in cost and decreased in efficiency; construction and operating materials have more than doubled in price; chemicals have advanced from 50 to 100 per cent; the operating and maintenance expenses have increased approximately one-third, while the normal annual increase in revenue has in general decreased. These are the findings of the special committee of the American Water Works Association appointed to compile information concerning the effect of war conditions upon the water works of the United States. Data were obtained from about 50 municipally and corporately owned water works plants in the United States. The committee, consisting of Leonard Metcalf, chairman; George A. Johnson and George W. Fuller, has collected this material in a report, from which the matter following is extracted.

### Construction Labor and Material Costs.

**Advance in Costs of Unskilled Construction Labor.**—The report from 44 American water works indicate an average advance over pre-war prices prevailing in 1915 of 13 per cent in 1916 and 27 per cent in 1917, the fragmentary figures submitted for the opening of 1918 showing materially greater increase. It is important to note that comparison of past and present wage scales does not tell the whole story of increase in cost of labor to water works. Unfortunately, there has been marked decrease in efficiency. The estimate of percentage loss in efficiency, comparable with the efficiency of 1915 and prior thereto, varied from 20 to 50 per cent. The consensus of opinion seems to range between 25 and 35 per cent.

It thus appears that the loss in efficiency of labor is practically equal to its increase in wage. The full increase in cost of labor, due to the combined effect of increase in wages and loss of efficiency, is approximately 50 per cent in excess of the pre-war costs and nearly as much over those of 1916.

**Advance in Cost of Cast Iron Pipe.**—Cast iron pipe of 6-in. and larger diameter shows an increase in prices over those of 1915 of 26.7 per cent in 1916, and 112.9 per cent in 1917. The corresponding figures for 1918 are too fragmentary for averaging, but indicate a slightly smaller increase over 1915 than did the 1917 figures, by reason of the stabilizing effect of governmental control. The difference is nearly negligible, however.

**Advance in Cost of Valves.**—Reports from 11 water works in different parts of the country on the cost of 6-in. valves show an advance in price of 13.1 per cent in 1916, 71 per cent in 1917 and approximately 107 per cent in 1918, all as compared with pre-war prices.

### Advance in Cost of Operating Supplies.

**Coal.**—The prices paid for coal by 41 important water works, indicate an advance in prices in 1916, 1917 and early 1918, over those prevailing in 1915, of approximately 15, 74 and 117 per cent, respectively. It is interesting to note the variation in the different parts of the country. The East suffered in far greater measure than the South and the West; the Central States in like measure with the Southern and Western states in the years 1916 and 1917, and in greater measure than any of the other groups in 1918. Incidentally, it may also be noted that the prices of fuel oil reported for one large plant in Louisiana and one in California show an advance in price in the opening of 1918 of approximately 150 per cent over those prevailing in 1915.

Unfortunately, in coal as in labor, the advance in unit prices does not reflect the entire increase in cost, in as much as decline in quality of the coal has been very generally observed. Effort was recently made to obtain exact information upon this subject by the Indianapolis Water Co. through a study of the relative coal consumption per million gallons of water pumped during the past two years, or thereabouts. The results of this study indicate a decline in quality of the coal from 10 to 15 per cent, broadly speaking. The results are characteristic, rather than precise.

Carleton E. Davis, chief of the Bureau of Water of Philadelphia, reports that at one of their main pumping stations the increase in coal consumption during the past 12 months or so was 17.3 per cent per 1,000,000 gal. pumped, because of the inferior quality of the coal. At other stations a change in the type of pump or character of fuel used makes a comparison impossible.

**Advance in Price of Alum.**—The record of prices paid by water works for alum, in cents per pound, is interesting and significant. It is to be borne in mind, however, that it reflects the leveling effect of long-time contracts under a rising market. This is indicated by comparison of the prices submitted, with the average New York market prices, quoted from the Journal of Industrial and Engineering Chemistry.

The figures submitted indicate an advance in 1916 and 1917 over the prices of 1915, of approximately 30 and 34 per cent, whereas the advance in the New York market prices over the 1915 scale was 123 per cent in 1916 and approximately 72 per cent in 1917, the decline in the latter year reflecting Government control.

### Water Works Operation and Maintenance Costs.

Returns were received from 50 important water works concerning their gross annual revenue, operating expense including taxes but excluding depreciation allowance, and the resulting operating revenue applicable to depreciation allowance, fixed charges, dividends and surplus.

These records indicate, as do the construction records, that no marked change in conditions was felt until 1916; that the gross annual revenues for 1916 and 1917 were respectively 6 and 9 per cent in excess of those for 1915, but slightly more than those for 1914, on the basis of all the records received, or 8.5 and 13.5 per cent on the basis of the average of group averages. The normal advance in gross revenue, corresponding to the growth in population and in investment, would probably have exceeded 6 per cent per annum and may have been substantially greater than this amount.

The increase in operating expenses over those of 1914-15 was 6 and 19 per cent for 1916 and 1917, respectively, on the basis of all the records received, and 12.7 and 32.6 per cent on the basis of the average of the group averages.

The resulting operating revenues applicable to the depreciation allowance, fixed charges, dividends and surplus for 1916 and 1917, were respectively 6 and 2 per cent in excess of those for 1915, all on the basis of the average of all of the records received; and 3.4

and 0 per cent, respectively, in excess of 1915, on the basis of the average of the four group averages.

Broadly speaking, therefore, it appears that the increase in operating expense has substantially absorbed the normal increase in gross revenue and has left no revenue to carry the burden of additional investment. There is marked decline in revenue in the eastern group, however.

### Conclusions.

First. That the water works of the United States have suffered, through war conditions, large increase in construction and operation costs.

Second. That market decline in net revenue has resulted.

Third. These conditions did not begin to make themselves generally felt until late in 1916, and it was not until the latter part of the following year that they became serious. The desirability and continuity of employment tended to delay the advance in wages.

Fourth. The advance in cost of labor used in extension and minor construction work, by water works in this country, has gathered force in the last 6 months, and it is the general opinion of municipal and corporate managers that additional increases are certain to come during 1918 and thereafter, if labor is to be held.

Fifth. It is undesirable to replace old, well-trained forces, familiar with these water works properties, with other labor not having this familiarity, in the effort to hold the wages at a point below the general local standard for similar service. The character of the service would suffer and it would not be fair to labor.

Sixth. Serious and conscientious effort has been made by water works operators generally to reduce construction and operating forces to a minimum.

These reductions have in many cases already gone beyond desirable limits, even to reducing the working efficiency of the properties.

In other cases still greater economies are possible in better consumption of coal; waste reduction by increased use of controlling meters, pitometer surveys, and more frequent house to house inspection, and in quarterly instead of monthly meter readings of small meters.

Seventh. The general situation is a very serious one and has shown itself in increasing difficulty of attracting capital for necessary betterments. While extension of service is likely to be increasingly limited with the conditions of war, it would be unfortunate, if the activities of important industrial and commercial centers, particularly those concerned in governmental activities, should be thus circumscribed.

Eighth. The menace of the situation lies in the increasing difficulty under such conditions of maintaining constantly a water service safe from a sanitary standpoint, necessary for good fire protection service, and adequate for industrial, commercial and domestic needs.

Ninth. Public Service Commissions and other regulatory bodies have already recognized the danger of the present situation to the public as well as to the utilities, and are likely at least to afford such relief as may seem to them necessary to maintain credit, but it is imperative for water works operators to keep clear records, showing the actual change in conditions and prices of materials and labor, that these bodies may have uncontestable proof upon which to pass judgment as to the necessity for relief.

Tenth. It is imperative, in the interest of good service, that water works operators of municipally as well as corporately owned plants, should anticipate their construction and operation needs, as far as possible, and should be careful to obtain the necessary priority orders, that the quality of the water and the service rendered may not be seriously impaired in the future for want of construction and operation materials and supplies.

**Effect of Cold Weather on Meters at Wilmington, Del.**—Owing to the severe cold weather last winter about 1,600 meters at Wilmington, Del., had to be removed. In one week 400 frozen meters were taken out, while in the last week of January the electric machine of the Water Department thawed out 100 water services. The Department found frost 30 in. below the surface of the ground.

TABLE I—SUMMARY OF DATA UPON INCREASE IN COST OF LABOR AND MATERIALS TO WATER WORKS IN THE UNITED STATES AS REPORTED TO THE EXECUTIVE COMMITTEE OF THE AMERICAN WATER WORKS ASSOCIATION, MAY, 1918.

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| 2-way hydrants | 6 | 26.69 | 32.04 | 43.13 | 53.90 | $20.1 | $61.6 | $102.0 |
| [illegible] | | | | | | | | |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
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| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | |
| c. Eastern group | 9 | 1.12 | 1.72 | 1.48 | | 54.0 | 32.7 | |
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‡Average of monthly prices.

# Engineering and Construction Features of West Side Irrigation District, California

An irrigation system having several interesting features was placed in review last spring by the West Side District of Tracy, Cal. The distinctive features of the system include first a single pumping plant delivering water to two canals at different elevations through two separate pipe lines, and second, laterals following the property lines, irrespective of the slope of the land, the necessary drops being provided by relatively inexpensive structures composed of an earth fill across the canal and a corrugated metal pipe. An interesting description of the system appeared in Western Engineering, from which the matter in this article is abstracted. The district comprises about 11,500 acres of land on the west side of the San Joaquin Valley, about 75 miles east of San Francisco.

The slope of the land varies between 15 and 50 ft. to the mile. The land has been cultivated for about fifty years, hay and grain being the principal crops, but the rainfall is scanty and variable, ranging from 5 to 20 in. per year, so that occasional crop-failures occur. None of the land within the district has been irrigated. There are no streams from which a gravity supply could be obtained nor are the ground-water supplies sufficient for irrigation. The only practicable source of irrigation water is by pumping from the San Joaquin river.

Early in 1915 a temporary organization was formed among some of the land-owners in the locality, looking toward the formation of an irrigation district, and W. G. Hunter, of Stockton, was retained to report on the project. He recommended the building of a system consisting of an intake-canal extending from Old river, a channel of the San Joaquin river, to a pumping plant near Bethany on the Southern Pacific railroad, two pressure pipe-lines, part reinforced concrete and part wood-stave, one line about 4,000 ft. and the other about 9,000 ft. long, each supplying a main canal, together with laterals and minor structures. The estimated cost of this system was $285,000, based on prices prevailing at that time.

The detailed estimate for the system chosen was as follows:

| | |
|---|---|
| Intake canal— | |
| Excavation (222,600 cu. yd. at $0.11) | $ 24,486 |
| Bridges | 4,000 |
| Right-of-way | 3,514 |
| Total intake canal | $ 32,000 |
| Pumping plant | |
| Building (inclusive of sump, foundations for machinery, incidental equipment and station grounds) | $ 18,000 |
| Pumping machinery | 24,500 |
| Total pumping plant | $ 42,500 |
| Pipe-lines | |
| Concrete pipe | $ 9,000 |
| Wood-stave pipe | 66,800 |
| Railroad crossing | 4,500 |
| Wooden bridges | 2,160 |
| Concrete highway bridge | 600 |
| Right-of-way | 2,700 |
| Total pipe-lines | $ 85,800 |
| Canal excavation, 265,000 cu. yd. at $0.13 | $ 34,450 |
| Structures— | |
| Railroad crossings | $ 7,000 |
| Highway crossings | 16,800 |
| Farmers' bridges | 7,500 |
| Stop-gates | 1,200 |
| Check-gates | 900 |
| Lateral-gates | 4,920 |
| Drops | 10,500 |
| Fences | 4,500 |
| Telephone lines | 3,500 |
| Lining canals, where required | 1,600 |
| Total structures | $ 58,420 |
| Right-of-way | 6,830 |
| Engineering, legal and administrative expenses | 25,000 |
| Grand total | $285,000 |

On a basis of 11,500 acres in the district, the cost per acre would be $24.78. The probable annual cost was computed as follows:

Bond interest was assumed at 6 per cent, the bonds to be issued for 40 years, and the principal to be paid during the last 20 years of that period, thus giving ample time for the farmers of the district to establish themselves before paying the principal. On this basis the annual interest charge for the first 20 years would be $17,100 or $1.48 per acre. The charge for the second 20 years would be $24,847 or $2.17 per acre. Depreciation was figured at 5 per cent per year on the wood-stave pipe, 2 per cent per year for the concrete structures, and 3 per cent per year for the rest of the system. The total yearly depreciation was computed to be $8,120, or $0.706 per acre. Ditch-tending and canal maintenance was assumed at $0.50 per acre per year after all the district is using water, and $0.35 per acre per year during the first five years. Attendance at the pumping plant was figured on the basis of one engineer and one helper for the entire year and two additional engineers and one additional helper during the six months of the irrigation season. The attendance charge would be $4,350 per year, or $0.378 per acre. Assuming the cost of power as ¾ct. per kw. hour and the over-all efficiency of the pumping plant at 67.5 per cent, the charge for power would be $0.96 per acre-foot. Of the total area of the district, 10 per cent will probably never be irrigated on account of roads, buildings, farm-yards, etc. A 25 per cent allowance for canal losses should be made. Two acre-feet per acre per season will be needed for the land irrigated. For the first five years the average area under irrigation will probably be about 5,000 acres, and the total charge for power will be about $1 per acre per year. Later, when all the irrigable land is using water, the cost will be about $2 per acre. For the first five years the probable annual cost per acre would be as follows:

| | |
|---|---|
| Bond interest | $1.48 |
| Canal attendance and maintenance | 0.35 |
| Pumping-plant attendance | 0.38 |
| Power | 1.00 |
| Total, exclusive of depreciation | $3.21 |
| Depreciation | 0.70 |
| Total | $3.91 |

For the next 15 years, the probable annual cost, including depreciation, would be $5.06 per acre. For the next 20 years, the probable annual cost will be $5.75 per acre. Should three acre-feet per acre be required during this period, the cost of power will be increased proportionally, and the total probable cost will be $6.75 per acre.

The district was formed in October, 1915, and Mr. Hunter was retained as chief engineer for the district. In May, 1916, he reported in favor of the construction of an irrigation system, substantially as outlined above, and this report was approved by C. E. Grunsky, as consulting engineer. The report, together with plans and estimates, was filed with State Engineer W. F. McClure on June 10, and on June 26, the plans were approved by him. Because of legal technicalities, the bonds were not voted until November, 1916. Similar technicalities delayed the sale of the bonds until June, 1917. They were then sold $270,000 to the City Bank of Stockton at 103.12 and $25,000 to the Bank of Tracy at 103.25. This unavoidable delay of a whole year, bringing, as it did, the period of construction into war times, was an expensive one for the district, both on account of the higher prices and of the delay in obtaining water.

Soon after the award of the first contract in December, 1916, it became evident that the money from the bonds would not be available until June, 1917. The rest of the work was therefore postponed until that time. The entire system was divided into 13 contracts. Contract No. 1 covered the intake-canal.

Contract No. 2 for furnishing power was awarded to the Sierra & San Francisco Power Co. at rates ranging from 0.55 ct. to 0.75 ct. per kilowatt-hour.

Contract No. 3, for furnishing the machinery for the pumping plant, was awarded to the Electric & Machine Equipment Co., of Stockton, for $56,718. The principal items of this equipment are as follows: Seven 15-in. Byron Jackson centrifugal pumps, three to deliver not less than 15½ cu. ft. of water per second each against a head of 64 ft. and with a speed of 875 r.p.m., and the other four to deliver the same quantity of water against a head of 126 ft. and at a speed of 1,160 r.p.m. The low-lift pumps to use not more than 175 hp. each and the high-lift pumps to use not more than 320 hp. Seven 2,200-volt, 3-phase, 60-cycle Westinghouse motors, three to develop 200 hp. and the other four 325 hp. Three Westinghouse transformers and one General Electric Co. switchboard. Two Byron Jackson priming-pumps.

Contract No. 10 is for constructing the two lines of reinforced concrete pipe from the pumping-plant building to a point near the Southern Pacific Co. tracks. One line 44 in. diam. is to receive the discharge from the three low-lift pumps, and the other line, whose diameter is 48 in., receives the discharge from the four high-lift pumps. The original intention had been to make these lines 48 in. and 54 in. diam., respectively, and the same with the wood-stave pipe-lines. On account of the increase in prices of materials and labor, however, it was decided, after comparing the saving in first cost for the smaller pipe with the increased annual cost for power, to use the smaller pipe. The pipe is to be made of 1:2:4 concrete, reinforced with twisted square bars. The pipe is to be laid in trenches six or seven feet deep. This pipe is now under construction. A 6-in. tile-drain is to be placed in each pipe-trench.

Contract No. 4, for furnishing, digging trenches for, and laying the wood-stave pipe-lines, was awarded to the Pacific Tank & Pipe Co., of San Francisco, for $79,300. There will be 3,900 ft. of 44-in. pipe and 9,250 ft. of 48-in. pipe. Laying this pipe is now under way. The trenches were excavated with an Austin trenching-machine. The depth varied from 6 to 9 ft., and the width was sufficient to give working-room to the men laying the pipe. The soil was a rather light "adobe" for about 3 ft. on the surface and a sedimentary loam below that point. The cutters on the machine were 3 ft. wide and the additional width was obtained by having men with long crowbars break off the material at the sides of the trench, the material falling and being caught on the cutters. About eight men were required back of the machine, using the crowbars, and also finishing the trench. The machine made about 100 ft. of trench per day on an average, being helped to some extent by the dryness of the soil during the construction period.

Contract No. 12, for the lateral-drops, lateral-gates, and farmers' bridges, presents some unusual features. Since the laterals follow the property-lines, a large number of drops, about 70 in all, are required. The original plans provided for concrete structures. The present plan is for a cheaper, but, it is believed, just as serviceable a structure. The drop consists of an earth fill across the canal, the same height as the canal-bank. Through this fill a corrugated metal pipe is placed, ranging in size from 18 to 30 in. diam., according to the amount of drop and quantity of water. Where a road is needed at that point, the fill is made 15 ft. wide on top. Where no road is required the fill is 4 ft. wide. The corresponding lengths of corrugated pipe are 30 ft. for a road and 18 ft. for no road. The places for the drop-structures have been chosen so that, as far as possible, they can also be used for check-gates. A similar construction is used for the farmers' bridges and here also a drop and road-crossing can frequently be combined.

As the work progressed, it became evident that the cost of constructing the system would be considerably more than the original bond issue. This was mainly because of the increase of prices since the original estimate was made. In this connection a study of the actual and estimated costs of the different parts of the system is of interest.

As might be expected, the pumping machinery showed the greatest increase of cost over the estimate. The total cost will be about $59,000, while the original estimate was $24,500. The cost of the building also shows a considerable increase, the contract price being $25,789, against $18,000 in the estimate.

Pipe-lines also proved to be more expensive than was expected, even though the sizes were decreased from one 54-in. and one 48-in. to one 48-in. and one 44-in. The estimate for the wood-stave pipe was $69,300. The actual cost will be $80,150. The estimated cost of the reinforced concrete pipe was $16,500 and the actual cost will be about $26,000.

The cost of excavating the canals will be about $55,000, whereas the estimated cost was $34,450. This was partly because of increased quantity of excavation, but mainly because the actual unit price was $0.18 per cubic yard, while the estimated price was $0.13. Canal right-of-way was also more expensive than was anticipated. The original estimate was based on a uniform price of $50 per acre, which the directors of the district decided to raise to $100 per acre. This increased the cost of canal right-of-way from about $10,000 to about $20,000.

Right-of-way for other parts of the system than the canals has cost more than was anticipated. It might be noted in this connection that the principal reason for increased cost of right-of-way has been the general increase of prices of land in the district since it was formed, which, in turn, is the direct result of the formation of the district. The increased cost of the work and the increased length of time required for its completion have caused an increase in engineering, legal, and other general expenses. The increased cost of the system emphasizes the advantage of the system chosen over the four pumping-plant system, since the latter system required a large amount of machinery, and the greatest increase of cost was in machinery.

Taking these facts into consideration, a revised estimate was prepared of $392,823 for the cost of the system, or about $34 per acre. The original bond issue of $295,000 sold for $304,250, leaving $88,273 to be raised. To provide for contingencies, the Board of Directors of the district, at Mr. Hunter's suggestion, decided to make the additional bond issue $100,000, and called an election for Feb. 19 to vote on the issuance of these bonds. This additional bond issue will increase the interest charges on the land in the district about $0.48 during the first 20 years and the interest and sinking-fund charges $0.64 during the next 20 years.

The construction of the system has been in charge of W. G. Hunter, of Stockton, chief engineer for the district, with C. E. Grunsky, of San Francisco, as consulting engineer. The system has been planned so that additional land can be taken into the district and served with water at some future time. The most favorable direction for expansion of the district is to the east.

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# Methods of Making Sewer Pipe Joints

In a topical discussion last January before the Sanitary section of the Boston Society of Civil Engineers much interesting information was brought out on the various methods of making joints in sewer pipe. The discussion is printed in the February Journal of the Society, from which the following matter is abstracted:

**Experiences of Metcalf & Eddy, Consulting Engineers, with Poured Joints.***—Prior to 1907, Metcalf & Eddy specified cement mortar joints for vitrified pipe in seperate sewers as well as storm drains, but since that year some form of poured joint has been generally used in their practice, where it was essential to keep out ground water.

The cement mortar joints are now specified as follows:

> The joints shall be as nearly water-tight as possible, and shall be made with a gasket of hemp or jute and cement mortar composed of one part of sand and one part of Portland cement. The gasket shall be soaked in a satisfactory mixture of neat Portland cement and water and then inserted between the bell and spigot and carefully calked into place with suitable calking tools. The gasket shall be in one continuous piece for each joint and of such thickness as will bring the pipe to the required relative position. The remainder of the joint shall be filled with cement mortar applied with the hands, protected with rubber mittens, well pressed and calked into place, after which the joint shall be beveled off with mortar for a distance of two inches from the outer edge of the bell. The joint shall be wrapped in unbleached cotton cloth, securely tied to prevent the mortar from slipping or being otherwise injured. No surplus mortar or other foreign substance shall project into the pipes from the joints, and if necessary, they shall be properly cleaned with a suitable scraper or by other means before the mortar becomes hardened.

It has been found difficult on contract work, to get sufficiently water-tight joints in this manner, although the use of cheesecloth for wrapping the joints was of value in preventing the bottom of the joint from falling off.

A mixture of sulphur and sand—using equal parts by volume of flour of sulphur and very fine sand—was used on several contracts. Unless the sand is very fine and practically free from clay the resulting joint is apt to shrink on cooling, causing objectionable cracks. Further, the sand, if too coarse, tends to settle out of the mixture, causing trouble in pouring and shrinkage of the joint. Some very successful work, however, has been done with this material. It appears to require more care in heating than some other mixtures. The chief difficulty has been to get a satisfactory mixture, due almost entirely to the size and quality of the sand. On contract work, this is a disadvantage. The joint, also, is absolutely rigid, as is the case with cement mortar.

When using sulphur-sand joints, the joint, after being poured and while warm, was coated with hot tar as a further precaution against leakage.

During the last few years, a number of compounds for jointing vitrified pipe have been placed on the market. Since 1913, Metcalf & Eddy have used that known as G-K compound, now made by the Atlas Co. of Lincoln, N. J. This material, said to be made largely of vulcanized linseed oil and clay, resembles vulcanized rubber or coal tar in appearance. It is delivered to the work as a solid, in barrels. It is easily melted by heating in an iron kettle over a fire, preferably using gasoline or kerosene, so that the heat may be controlled.

Specifications for making this form of joint as well as sulphur-sand, are as follows:

> Where plastic joints are specified, the pipe shall be laid as previously specified, and the joints shall be thoroughly calked with a gasket of hemp or jute in one continuous piece, and of such thickness as will bring the pipes to the required relative position. The gaskets shall be calked dry and shall form a water-tight joint. The plastic compound to be used in jointing the pipes shall be that known as ——— compound, manufactured by ———, or other plastic jointing material satisfactory to the engineer. The compound shall be heated in a gasoline or other suitable furnace, to a temperature slightly above that at which it will pour rapidly and smoothly; at which it shall be kept until used. After the pipe joint has been calked, the melted compound shall be poured into the joints by the use of a joint runner or gasket, in a similar manner as lead joints are poured. In case the pipe joint is not completely filled, that part of the joint shall be poured again with hot material, to form a complete water-tight joint. Wherever permitted, sections composed of two or three pipes may be jointed at the side of the trench, provided the pipes are set in a suitable wooden cradle to ensure true alignment. In lowering sections, so made, into the trench, a piece of timber shall be run through the pipes in order to support their weight and prevent the joints or bells from being broken.

Asphalt has not been used, or any of the bituminous compounds, to any extent, because of the danger of hot water or steam melting out the joint due to the low melting points of most of these materials. With a sufficiently high melting point, this objection would be covered.

Some trouble has been experienced during cold weather with G-K compound, due to its failure to stick to the pipes, especially in the smaller sizes where the inside of the bell is glazed and there are no scorings.

From tests made both in the laboratory and on contract and day labor work, the results obtained with G-K compound have been satisfactory.

The cost of a jointing material and labor will be from 50 per cent to 100 per cent more with a poured joint than with cement, judging by average prices received. Part of this excess cost is doubtless due to the unfamiliarity of contractors in general with poured joints for vitrified pipe.

Sheet metal forms and gaskets for pouring cement grout joints have recently been placed on the market by Mr. L. A. Weston, of Adams, Mass. The writer understands that the price of the gasket is 10 ct. for a 10-in pipe and 10 ct. for the form, thus making a cost of 20 ct. per joint for the form and gasket. The gasket, of course, is left in place, and it would appear probable that the form, also, would be left in place, as a rule. The gasket is made to fit over the spigot end of the pipe, being tightened with a screw driver. The notches in the edge are pliable so that the gasket adjusts itself to the inequalities in the pipe hub. No jute is required.

The form provides for pouring the lower half of the joint, the remainder being filled by hand with cement mortar. The form is held in place by wires.

In order to offset the expense of the form and gasket, a material saving in labor cost must be made in addition to the saving in cost of materials over poured joints using other materials than cement.

The writer believes that a poured joint is the most desirable form of joint yet devised where it is essential to prevent the entrance of roots and ground water. Good results have been obtained with a sulphur-sand mixture, with bituminous compounds such as those manufactured by Warren Bros., Boston, the Pacific Flush Tank Co., New York, the Standard Paint Co., Boston, and others; and with G-K compound, made by the Atlas Co., Lincoln, N. J. On contract work, these commercial compounds may have some advantages from the contractor's viewpoint.

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*From the discussion of Frank R. A.A Marston, Designing Engineer, with Metcalf & Eddy, 14 Beacon St., Boston, Mass.

On account of the imperfections in the so-called "standard" socket sewer pipe it is almost necessary to use "deep and wide" socket pipe if poured joints are to be adopted. Otherwise there is liable to be insufficient space for the flow of the jointing material.

**Experiences at Pawtucket, R. I., with Mortar Joints.**†—We have had no experience with the poured joint in Pawtucket, for we have adhered to the old-fashioned mortar joint. In recent years we have required the mortar to be placed by hands covered with rubber mittens rather than by the trowel, and we have recently used a strip of cloth about nine inches wide to cover the joint after it is made. This strip of cloth is laid on the ground, partly under the bell of the pipe last laid, and mortar is spread on the cloth and in the bottom of the bell with a trowel. A gasket is then placed around the spigot of the pipe to be laid, and it is inserted in the bell of the other pipe, care being taken not to disturb the mortar spread on the bottom of this bell. The pipe is pushed home, brought to proper line and grade on the bell end and the gasket is calked. The joint is then filled with Portland cement mortar proportioned 1 to 1, especial care being taken to see that this mortar is crowded into the joint on the under side of the pipe. The mortar joint is beveled with a trowel, or by the hand, and then the two ends of the strip of cloth are brought up around the joint and tied together over the top of the bell. This serves as a protection to the green mortar, holding it tightly up against the joint and preventing its disturbance as the backfilling progresses.

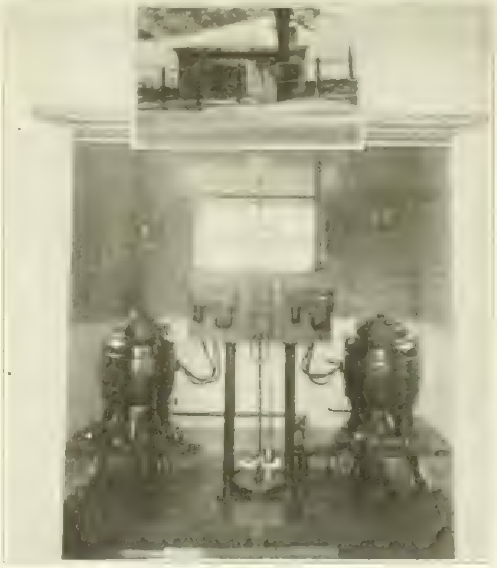
After all is said, however, the integrity of the sewer joint depends, in large measure, upon the inspector. If he is not on the job all the time, watching the joints as they are made, the workmen will get careless. The joints will be perfect on the top where they are readily inspected, but on the bottom, where there is the greatest necessity that they should be tight, they are apt to be neglected.

## Steam Jet Outfits in Hydraulic Fill Construction in Winter

Steam jet outfits similar to those used in placer mining in Alaska were employed by the Fargo Engineering Co., Jackson, Mich., in winter work on the construction of hydraulic fill at the Junction Dam of the Consumers Power Co., in Michigan. During the winter months the fill was placed at temperatures generally well below freezing, but with reasonable care very little ice was deposited in the embankment and there was no tendency for the sluiced material to freeze as long as water ran over its surface. Sluicing was discontinued during periods when the temperature remained below 15° F. In some cases it was necessary to thaw out the frozen ground before resuming sluicing. This was done with the thawing outfits, which consisted of a steam main with several 1-in. hose branches connected to $^3/_4$-in. pipes 6 to 8 ft. long. Live steam at a pressure of 10 to 30 lb. was used. By spacing the jets about 6 ft. apart frozen sand could be thawed to a depth of 3 to 5 ft. in from 4 to 6 hours.

## Small Automatic Pumping Station Solves Drainage Problem at Brookline

The town of Brookline found it necessary, during the year of 1917, to devise a method of disposing of the drainage from four contagious hospital buildings, the almshouse and high service pumping station, with provision for a school house and other buildings in an outlying section of the town. The natural drainage outlet for the section in question was through private property and Walnut Hill Cemetery to West Roxbury, a part of the city of Boston, and at a distance of about 1 mile. As the city of Boston has no sewer in this water shed nearer than 1 mile, and as this section is not at all developed, and in no immediate need of sewerage, it would have been difficult, if not impossible, to have gotten Boston to furnish a sewer outlet unless the town of Brookline contributed liberally to its cost.



Interior View of Automatic Sewage Pumping Station of Brookline, Mass. Inset Shows Exterior View of Station.

It would have been possible, by laying several thousand feet of temporary sewer, to get an outlet into a city of Boston sewer in another water shed, but this would have involved the taking of rights of way through private land, and it was impossible to say how long the city would allow this extra territory to drain into a sewer which was not designed to care for it. The topography is such as to allow an outlet through certain other sections, but this route was through a section of the town that would probably not need a sewer for many years, and the cost would have amounted to $100,000 or more.

It was finally decided to build a small automatic sewage pumping station to lift the sewage to the town's own sewer in Clyde St. This involved in addition to the plant itself the laying of about 1,700 ft. of 6-in. cast iron pipe. A small concrete and brick structure was built at the junction of Newton and Grove Sts.

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†[illegible] Pawtucket, R. I.

The equipment consists of a Yeomans Form "A" automatic electric sewage ejector equipped with Wagner polyphase motors of 200 volts, Cutler Hammer starters and General Electric oil switches. The unit is of the duplex type, each side having a capacity of approximately 300 gal. of sewage per minute, and when both units are in operation a capacity somewhat in excess of 400 g.p.m The station is entirely automatic and is so arranged that if the inflow is in excess of the capacity of one unit, the float mechanism will start the second unit. As an emergency provision an alarm signal has been installed in the high service station of the town of Brookline, a short distance away, so that in the event of any failure of the ejector immediate notification is given to the operating force at the pumping station. The total cost of the station, equipment and force mains was approximately $13,000.

Mr. H. A. Varney, Town Engineer of Brookline, and his Resident Engineer, Mr. F. A. Leavitt, were in charge of the design and engineering details in connection with the work.

The equipment was installed by the Power Equipment Co. of 131 State St., Boston, Mass. New England representatives of the ejector manufacturers, Yeomans Brothers Co., 215 Institute Pl., Chicago.

## C. E. Drayer Elected Secretary of American Association of Engineers

The Board of Directors of the American Association of Engineers, with headquarters at 29 S. La Salle St., Chicago, announce the election of C. E. Drayer as secretary.

Mr. Drayer has been actively engaged in engineering society work of local and national character for the past eight years. After graduation from college in Cleveland, O., he served on western railroads until 1910, when he returned to Cleveland to become field engineer for the Nickel Plate R. R. on grade elimination work. He immediately joined the Cleveland Engineering Society and began to put into practice as opportunity offered ideas of advancing the engineer in public esteem and of engineers training themselves to be leaders in service to the community. After two years of marked success in Cleveland he began to carry the message to other societies and in time addressed most of the engineering organizations east of the Mississippi. In 1915 he became associated with Dr. F. H. Newell in forming the Committee on Engineering Co-operation, of which he is secretary. He organized and is secretary of the Ohio Association of Technical Societies. He is co-editor of Engineering as a Career, a series of articles of advice to young men. For several years he was editorial correspondent for "Engineering News" and "Engineering News-Record," where most of his articles on engineering organization have appeared. He served the Cleveland Engineering Society as its secretary for two years and was a member of its Board of Directors when elected secretary of the American Association of Engineers. He formulated the plan of combined membership between the American Association of Engineers and the Cleveland Engineering Society. Present indications are that this plan will be adopted by other societies and that it will have a profound influence on engineering organization.

The New Secretary of Am. Association of Engineers.

## Operating Costs of Grand Rapids Filtration Plant

The total operating costs of the filtration plant of Grand Rapids, Mich., for the year ending April 1, 1918, showed an increase of 24.1 per cent over the previous year and an increase of 62.8 per cent over the year 1915-1916. These increases, states Walter A. Sperry, chief chemist of the filter plant, in his annual report, are consistent with the present difficulties of obtaining supplies both as regards quality, production and delivery. Lime has increased in cost 39.5 per cent over 1916-17 and 55.8 per cent over the year 1915-16, and dropped off in yearly average quality from 88 per cent water soluble calcium oxide in 1915-16 to 83 per cent in 1916-17 to 77 per cent last year. Alum has increased in cost 11.9 per cent as compared with last year and 22.7 per cent as compared with the year before. Hypochlorite of calcium has increased in cost 5.5 per cent over 1916-17 and 50.8 per cent as compared with 1915-16, though it should also be reported that in March of 1918 there was a 20 per cent drop in the price of the "hypo" as compared with the average price for the year.

**Government Orders 244 Miles of Wood Stave Pipe.**—The U. S. Government has placed a further order with the Continental Pipe Manufacturing Co., Seattle, Wash., for 230,000 ft. of machine banded wood stave pipe, varying in sizes from 6 in. to 18 in. in diameter. It will require over 100 railroad cars to deliver this order. This pipe is being made of Douglas fir lumber. It will require over 1,000,000 lb. of wire, and 1,500,000 ft. of lumber to complete this one order. The three large plants of the Continental Pipe Manufacturing Co., located in the Douglas fir belt of Oregon and Washington, have previously furnished pipe on Government orders amounting to 200 miles or 625 carloads.

**Thawing Frozen Ground with Asphalt Blast Pan.**—A blast pan, such as is employed by street repair gangs in asphalt surfacing, is used by the Water Department of St. Louis, Mo., during the winter months when frozen soil conditions make the excavation for repairs of broken mains difficult. The pan has proved an effective method of dissipating the frost and expediting the excavation.

Railways and Government Works
Monthly Issue

ENGINEERING AND CONTRACTING

HALBERT P. GILLETTE, President and Editor. LEWIS S. LOUER, Vice President and General Manager

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering field. See advertising page for further information and subscription coupon.

**Roads and Streets—1st Wednesday**
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies

**Waterworks and Hydraulics—2nd Wednesday**
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power

**Railways and Govt. Works—3rd Wednesday**
(a) Excavation and Dredging
(b) Rivers and Canals
(c) Harbors and Docks
(d) Railway Construction

**Buildings and Structures—4th Wednesday**
(a) Buildings
(b) Bridges
(c) [illegible]
(d) Miscellaneous Structures

Volume 1. CHICAGO, ILL., AUGUST 21, 1918. Number 8

# The "Skip-Stop Plan" of Saving 10% in Street Railway Fuel and a Greater Per Cent in Trip Time

Even in America and in this "age of publicity," it is astonishing to observe the slowness with which any new economic method or device comes into general use. Mental inertia or resistance to change characterizes even the most intelligent of peoples. When mental inertia is coupled with downright ignorance, as so often is the case, economic progress is indeed painfully slow. The war has served to overcome a great deal of our mental inertia, because necessity has forced us not only to open our eyes but to act.

A good illustration of this is had in the recent rapid spread of the skip-stop plan of operating street cars. The plan is not new. It was successfully worked out in Kansas City more than seven years ago. But after its economies and other advantages had thus been demonstrated, not a baker's dozen of our street railways had adopted it 18 months ago. Then came our entrance into the war, followed by a coal shortage. Whereupon the War Board of the American Electric Railway Association presented to the U. S. Fuel Administration data to prove that 1,500,000 tons of coal could be saved annually by the universal adoption of the skip-stop plan of street railway operation.

American street railways use 16,000,000 tons of coal annually. About two billion car-miles are traveled annually, and about 9 stops are made per mile, or 18,000,000,000 car stops per year. The power required to accelerate a car after each stop causes the consumption of about half a pound of coal; so that 4,500,000 short tons of coal are annually used merely to accelerate street cars. It is conservatively estimated that one-third of the stops can be eliminated by the skip-stop plan, resulting in an annual saving of 1,500,000 tons or about 10 per cent of the coal now used by street railway plants. These estimates are confirmed by actual results. The street railway system of New Haven, for example, has reduced its power consumption by 10 per cent since the adoption of a skip-stop plan.

There are several modifications of the skip-stop plan, but the plan in general involves the abandonment of the practice of stopping every car at any street corner upon signal from a passenger entering or leaving the car. There are six common varieties of the skip-stop plan: (1) Alternate corner skip-stop, (2) Staggered skip-stop, (3) Odd and even skip-stop, (4) Selective skip-stop, (5) Measured skip-stop, and (6) Express skip-stop. In the "alternate corner" plan, both the inbound and outbound cars stop at the same corners, and at every other corner, thus skipping every other corner. The "staggered" plan gives a stop at every corner by either, but not by both, the inbound and outbound cars. The "odd and even" plan involves having cars marked with an odd number stop at streets having an odd number or where an "odd" sign is placed, and similarly for the "even" cars and streets. The "selective" plan involves stopping only at selected places, not necessarily every other corner. The "measured" plan is a European plan not favored in America, and it involves stopping cars at uniform distances apart, say 600 ft., regardless of whether these stops are at corners or between corners. The "express" plan involves making very few stops by certain cars known as "express cars," and using "local cars" to pick up passengers at points intermediate between the express stops.

The saving in fuel is not the only economy effected by the skip-stop plan. The time lost in making each stop averages [illegible] of a minute, half of which is due to the time lost in slowing down and in recovering the speed, and half in taking on and letting off passengers. By dividing the percentage reduction in stops by two, we get approximately the percentage increase in average speed of cars. Hence if the number of stops is decreased one-third, the average speed is increased one-sixth. On such a basis, the same platform men (motormen and conductors) would travel nearly 17 per cent more miles daily, with a corresponding reduction in wages per car-mile. This saving fully equals the saving in fuel in dollars per annum.

The saving to the passengers is an average time saving of almost 17 per cent also, for the added time of walking an additional average of 150 ft. is only half a minute, as compared with an average 5-minute saving in a one-way trip. Usually a street-car company does not decrease the number of its cars in active service, after adopting the skip-stop plan, and thus reduces the waiting time of passengers, while also providing more passengers with seats in the rush hours.

In nearly all the cities where the skip-stop plan has been tried, a great majority of the passengers have voted for its continuance. Ballots have been provided for the passengers to cast on leaving the cars on an appointed "election day," and the usual verdict has been fully 3 to 1 in favor of the skip-stop. In Cleveland it was 4½ to 1. The opposition comes mainly from the short-trip riders, from those who are antagonistic to the street railway company, from people who are too lazy to be willing to take a short additional walk each trip, and from merchants whose stores are not on the corners where stops are made. Since the skip-stop plan is not ordinarily applied in the down-town or business district, the opposition of merchants is not serious.

The opposition of selfish and shortsighted people can be largely overcome by a proper publicity campaign.

We have given quite an extended outline of the skip-stop plan because we believe it to be one of those economic public service methods which all good citizens should support. Engineers in particular should favor the skip-stop, for they, better than most men, can see its economic justification. In fact it has been largely through the work of street railway engineers that the merits of the plan have become more generally appreciated. If engineering societies will vigorously support the skip-stop plan, its universal adoption will be greatly hastened.

## Is the Reinforced Concrete Freight Car an Economic Possibility?

The concrete ship has arrived. The concrete freight car is about to arrive. Next we may hear of concrete automobiles. Already mechanical engineers are said to be experimenting with concrete steam boilers. Reinforced concrete designers are invading every field in which structural steel has hitherto enjoyed a monopoly.

During the last two years cement mortar, sprayed by a cement gun, has been successfully used in repairing the bodies of steel cars. Naturally the question has been asked: Why not build an entire freight car body of reinforced concrete? And it is being answered, for the M. E. White Paving Co. of Chicago is building an experimental freight car.

This first car is to be a gondola, 40 ft. long, with a capacity of 100,000 lb. It will require only 6,000 lb. of steel, as against 32,000 lb. in an all-steel car, and will cost less than a steel car.

As to the strength, cost and durability of a reinforced concrete freight car, few structural engineers will doubt its ability to compete with an all-steel car. The only economic doubt relates to the feasibility of building a concrete car as light as a steel car of equal capacity. Concrete ships are somewhat heavier than steel ships of equal capacity. This is not so serious a matter where water transportation is concerned, but in rail haulage it is vital to secure a minimum of dead weight.

It has been suggested that concrete ships should be built of volcanic tuffa, a porous and therefore very light rock. But the porosity, while desirable in one respect, is objectionable in another respect. Sea water would thus more readily penetrate to the steel embedded in the concrete and rust it. In a freight car, however, concrete made of tuffa or cinders might not be so objectionable.

In the design of the body of a freight car it will be feasible to use corrugated expanded metal or mesh, upon which a thin cement mortar can be applied with a cement gun or otherwise. Thus strength and rigidity may be secured with very little steel and no great amount of cement mortar. Corrugated steel would be used more often by structural engineers were it not for its short life when exposed to the weather. But if well coated with waterproof cement mortar, corrugated steel would last indefinitely.

When all-steel cars were first invented, great expectations were aroused as to their probable long life and low maintenance cost. There has been not a little disappointment over the actual results. If the sides are made thin enough to reduce weight and first cost to a desirable minimum, they not only rust through quickly but are readily battered out of shape. Moreover, it is impracticable to keep paint on the inside of the car, because of the abrasive action of the load; and repainting the outside must be frequent to be effective. A concrete car would, therefore, incur much less maintenance expense and have a longer life than a steel car. So the ultimate economic success of the concrete car is entirely dependent on the feasibility of making it as light as an all-steel car of equal capacity. It seems to us that this can be accomplished.

## Henry Ford's Criticism of Railway Rolling Stock

A light automobile weighing 1,800 lb. comfortably carries 5 passengers; whereas a railway coach weighing 90,000 lb. seats only 70 passengers. Hence a railway coach has three and a half times as much deadweight per passenger as a "touring car." It is true that the coach has a substantial roof and sides and that it is roomy enough to make it comfortable. On the other hand, a touring car carries its own motive power and must be strong enough to withstand impacts on the roughest country road.

Henry Ford says that is in the design of passenger coaches and freight cars the railways are years behind the times. He points out that the designers of railway rolling stock have failed to utilize modern knowledge of light alloys and structural principles. Ford says:

> Passenger trains weigh 30 to 150 times as much as the passengers in them. Four-fifths of a railroad's work today is hauling the dead weight of its own wastefully heavy engines and cars. This is why railroad presidents have such a hard time to figure out freight and passenger rates on the 20 per cent of live load to cover the cost of hauling this enormous 80 per cent of dead weight around.

Criticism of railway management has been very common these past ten years, and doubtless much of it has been justified. But Ford and other critics whose profits have not been restricted by public service commissions overlook the fact that experiments involving the investment of large quantities of new capital are not likely to be made where the profits from such experiments are apt to be confiscated by the public. It is to be hoped that out of the present situation there will evolve a saner policy of railway regulation, a policy that will attract new capital, and enlist the most brilliant engineers and business managers in the service of our railways. To do this, however, we must scrap the old system of purely restrictive regulation of railways, and permit them to be operated so as to encourage capitalists to bet their money on the ablest engineers and managers. It is the veriest nonsense to speak of the railways as an industry that can not be developed to a much higher state of economic efficiency. If given adequate incentive, it is probable that in the next 20 years there will be little left of our present railways save their rights of way and station grounds.

## "Let Us Learn Even From the Germans"

Many of our public schools have discontinued teaching German. While we believe in the wisdom of this act in so far as it concerns most of the students, we can not agree with the reasoning that has led to it. However much we may abhor the actions and teachings of German rulers and military men, we should not let ourselves be blinded to the scientific achievements of the Germans. Lloyd George recently said:

> [illegible] combination. Let us learn our lessons, wherever they come from —even from the Germans.

Any one who has familiarized himself with the work of German physicists and chemists during the past 20 years or more, is well aware that more discoveries in those two fields are due to the Germans than to any other nation. In our issue of July 31 we gave statistics showing that in applied science—engineering and invention—Germany has been far behind America and England. But let us bear in mind that in pure science —mathematical physics, etc.,—Germany has far surpassed America, and, in recent years, has also surpassed England.

Since many modern advances in engineering have followed prior advances in pure science, we should be dullards indeed were we to close our eyes to German discoveries in the realms of physics and chemistry. Yet precisely such dullness is shown by the reasoning of those who propose to stop the teaching of German because we hate many of the Germans. The public school, in the judgment of the editor, is no place to teach any foreign tongue, except to those who contemplate a career as scientists, engineers or the like. Except for a very few public school students, no foreign language is necessary or even desirable; but for a limited number it is highly desirable.

We are well aware that many engineers, particularly civil and mechanical engineers, who have studied French and German, assert that foreign languages have been of little or no use to them. That is true, but to many another engineer the converse is true, particularly in the fields of chemistry, metallurgy and electricity.

One of the crying needs of America is the existence of a large number of experimental chemists and physicists. We really should be ashamed of our very poor record in pure science discoveries. If we are to remedy this condition quickly we must first alter our belief in the invariable superiority of American scientific methods; and, second, we must put many a young man at work studying the scientific books and periodicals of Germany, England and France—to name them in order of recent priority in pure science.

In "The Electron Theory of Matter," by Richardson, professor of physics at King's College, London, 251 authorities are cited. We have analyzed these citations with the following startling results:

[illegible]

Note carefully the significance. Of 251 scientists whose experiments or mathematical analyses are mentioned by this English physicist, only 4 are Americans! Bear in mind that in a comprehensive discussion of the theory of matter, such as this treatise gives, almost every fundamental phase of electricity, heat and light is involved, in addition to a great part of chemistry. Then consider the miserably pitiful showing made by Americans. We are in a class with the Russians and Japanese. Yet we pride ourselves on our scientific achievements, and not without reason, as was clearly shown in our issue of July 31.

We have done wonders in applied science, and the wonder is that we have done so little in pure science upon which applied science is based. Prof. Dewar, of England, in his experiments with liquid air found it necessary to prevent it from evaporating rapidly; so he applied his knowledge of heat conductivity and radiation, and designed "a vacuum bottle." Whereupon some keen witted Yankee invented the "thermos bottle" and put it on the market very successfully. The "thermos bottle" is nothing but a commercially practical modification of Prof. Dewar's vacuum bottle. No man ignorant of the laws of heat transfer as determined by the "pure scientists" could ever have designed the vacuum bottle. We now have quite a large American industry based entirely on the laws of heat transfer as applied by an English professor who understood them. This is typical of many another industry.

The time has come when American engineers and inventors must be given the benefit of researches by American scientists, researches comparable in profundity and scope with those of the Germans and English. Coincidently we should be provided with translations of all important German books and articles. As yet American literature on mathematical physics and chemistry is lamentably meager. We have, for example, no comprehensive tables of physical constants. The best tables are the Smithsonian, and they are far from being adequate. Our textbooks on higher physics and chemistry are not to be compared with those of Germany and England in number or completeness. The transactions of our societies devoted to pure science are correspondingly weak.

Let us look such facts squarely in the face; and, while denying to Germany the spremacy that it claims in general efficiency, let us not deny, nor cease to profit by, the truly remarkable achievements of Germany's chemists and mathematical physicists.

**Capital Issues Committee Authorizes City to Sell $5,500,000 Bonds.**—The city of Seattle has been granted permission to sell $5,500,000 of bonds for developing a 35,000-kw. hydroelectric project on the Skagit River.

# Working Conditions and Pay of Government Clerks

To the Editor: In your issue of July 17 you have an article entitled "Should Government Clerks Have a Shorter Day Than Other Clerks." In this you criticize the president for vetoing the appropriation bill with the Borland rider providing for 8 hours as a minimum day for employes paid from the appropriation.

I believe your stand in this matter is a consequence of your not understanding conditions of work in the Government departments and the president's action was taken because he does understand them.

The term Government clerk is used in a general sense and includes all civilian Government department employes. As the Federal Government is now employing more engineers (not counting those in military service) than any other employer, the conditions of employment should be of interest to our engineering press.

The 7-hour day is rather a deceptive expression as the law provides a minimum of 7 hours' work with full authority vested in department heads to require more when necessary, and this provision has been made extensive use of since the war started without any objections from the employes.

No allowance for overtime is permitted and under that rule a clerk who is 5 minutes late in the morning but actually works 10 hours in one day has a record of being absent from duty 5 minutes, and no credit is given for the overtime.

The Borland amendment provided for a minimum day of 8 hours and no maximum limit or provision for credit for overtime.

Employes in field service conform in hours to the work they are located on and this frequently means 10 hours per day and make out reports in the evening. In other cases it only requires 7 hours per day and there is no possibility or necessity for 8 hours' work.

A week's work for a Government clerk in Washington is a minimum of 7 hours for 6 days or 42 hours per week except for 3 months in summer when it is 39 hours on account of 3 hours off on Saturday afternoon.

Most corporations in engineering work have 5 days of 8 hours and Saturday of 4 hours or a total of 44 hours per week. About all organized labor works on this basis.

Most states and cities have a 7-hour day for 5 days and 3 hours for Saturdays or 38 hours per week, and the Federal Government is usually considered to be representative of the states.

The salaries paid by the Federal Government are very low. The average yearly salary for 1916 was $1,038 (which is not sufficient to support a family) with an increase in 1917 of 10 per cent to $1,000 and 5 per cent to $2,000 per year.

In 1918 a raise of $120 per year was allowed up to $2,500. These increases are temporary and do not in any wise cover increased cost of living during war times, also exceptions made leave a large percentage without any increase.

It is not customary to attempt to increase working hours without increasing pay and the Government does not allow private concerns to do so during war times.

The regular staff of Government clerks accepted employment under the 7-hour day and it can scarcely be considered a fair deal to increase it without increasing the pay.

Every department head has at present ample authority to require additional hours of labor when any necessity arises for it.

Many corporations have a pension system to retire aged employes, but the Government has an efficiency system which directs department heads to discharge civilian employes who become too old for efficient work.

Many clerks accepted Government positions in order to study out of office hours and fit themselves for some other business, and many have to take outside work to make a living for their families.

In 1917 union labor exercised enough influence to defeat the Borland amendments. In 1918 the president was wise enough to veto it.

The engineering societies and papers have taken but little interest in the welfare of engineers and the engineers are beginning to find out that they need help in this line.

The American Association is the only society active in this line and they have grown rapidly on the strength of assisting their members to keep employed at any salary possible.

Wages of engineers now compare very unfavorably with that of tradesmen and more particularly with union labor.

Mr. Borland has been repudiated by his constituents by being defeated for renomination. His amendments were vetoed by the president and the heads of departments disapproved them. The Government employes most certainly objected to them.

The attached clipping shows that engineers (including draftsmen) are turning to the trade unions to help them as they realize that engineers are confronted with poor prospects and at present are in a subordinate position to union tradesmen as far as realizing returns on their work.

O. W. Childs.

Washington, D. C.

[The clipping from a Washington newspaper referred to by Mr. Childs follows in part.—Editor.]:

> The Washington Society of Draftsmen was formed last night and as Union No. 16137, was affiliated with the American Federation of Labor, with a membership of 1,000 draftsmen from the War and Navy Departments, the navy yard and several other divisions of the Federal Government.

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**Heat Values of Wood**—One cord of dry birch, according to the Forest Products Laboratory, Montreal, Que., has a heating value equal to that of 1 ton of anthracite. The heating values of other classes of dry wood on this basis follow:

1.15 cord of tamarack.
1.20 cord of douglas fir.
1.50 cord of jack pine.
1.55 cord of poplar.
1.60 cord of hemlock.
2.10 cord of cedar.

The above comparison is based on the supposition that the calorific value of coal is 13,000 B. T. U. It is stated that the grade of coal received in Canada last winter was possibly as low as 10,000 B. T. U., which in comparison would reduce the stated quantities of wood by 23 per cent.

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**18,000 War Department Trucks Overseas.**—On July 1 the U. S. War Department had overseas 4,308 motor trucks of less than 1-ton capacity, 5,703 1½-ton trucks, 7,987 3 to 5-ton trucks, and 3,420 passenger cars. Prospective deliveries of motor trucks to the Department for July were 4,797; for August, 4,355; and for September, 4,448.

# New Form of Contract Reduces Risks in Contracting

The State of South Dakota, like many other states, is, just at present, having some trouble in securing contractors to look after State highway work. In an effort to relieve this trouble as much as possible as well as to reduce the risk involved in contracting as far as is practical, the Highway Engineer, Mr. Frank Peck, had a new form of contract drawn up and submitted to the prospective bidders at a recent letting. The contract is interesting both because of the manner of adjusting the risk of contracting which, in general, follows the Massachusetts idea, and because of the manner in which the contract deals with the problem of financing contracts of this nature in those states where all payments must be by warrant and force account work is, therefore, almost impossible because of the highway engineer's inability to pay labor promptly.

The form of contract follows:

ALTERNATE FORM OF CONTRACT.

This Agreement made this day of A. D. 19 between the State of South Dakota, through its State Highway Department, hereinafter called the party of the first part, and ........................................

of [illegible] or [illegible] executors, administrators and assigns, hereinafter called the party of the second part, WITNESSETH:

That for, and in consideration of the payments hereinafter mentioned to be made by the party of the first part, party of the second part agrees to furnish all materials, appliances, tools and labor and to perform all work required for the [illegible] of that certain portion of the public highway in County, State of South Dakota, designated as ....................

................................................................

beginning

and ending

according to the attached plans and specifications and to the satisfaction of the party of the first part.

The party of the second part further covenants and agrees that the following papers shall be bound with and be an essential part of this contract, to-wit: the Plans, Notice to Contractors, Specifications, Proposal and Contract Bond.

In consideration of the furnishing of the materials, appliances, tools and labor, and performing all work required for the completion of this contract, the party of the first part covenants and agrees to reimburse the party of the second part for the actual cost of all labor and materials, the use of which in the performance of this contract has been authorized by the party of the first part, except as hereinafter provided, and to further pay the party of the second part the sum of* ........................ Dollars, which sum is mutually agreed to cover the cost of furnishing all tools, appliances, equipment, supervision (other than foremen in actual field charge of construction work) and a reasonable profit.

It is also mutually agreed that if the unit cost of the labor and the materials necessary for the performance of any item or items included in this contract is less than the estimated unit cost as set forth in the proposal, the party of the first part will, except as hereinafter provided, pay to the party of the second part, as a bonus, one-half of the total amount by which the actual cost of this item, or these items, is less than the estimated cost as calculated from the engineer's certificate of the number of units performed and their estimated unit cost as set forth in the proposal.

It is further mutually agreed that if the actual unit cost of the labor and materials used in performing any item or items named in the proposal shall exceed the estimated unit cost as set forth in the proposal, one-half of the difference between the actual cost of this item, or these items, and the estimated cost as calculated from the engineer's certificate of the number of units performed and their estimated cost as set forth in the proposal, shall be deducted from the lump sum herein provided to cover the cost of furnishing tools, appliances, etc., or from any bonus accruing on any other item or items included in this contract, but no deductions made under this provision shall reduce the lump sum payable to the party of the second part for tools, appliances, etc., below the sum of† [illegible] Dollars.

It is further mutually agreed that in order to guarantee the prompt and efficient execution of the work herein provided for, the party of the second part will deposit not later than [illegible] after the execution of this contract, in a bank to be designated by the party of the first part, as the fiscal agent for the party of the second part, the sum of‡ [illegible] which deposit may be withdrawn only on the order of the party of the second part, countersigned by the authorized representative of the party of the first part who will authorize its withdrawal only for the payment for labor and materials authorized and used in the execution of this contract.

It is further agreed that, from time to time thereafter, as the necessities of the work require, the party of the first part will make payments to the party of the second part, through the above mentioned bank as the fiscal agent of the party of the second part, which payments shall be by warrant and shall be receipted for by the bank as the agent of the party of the second part, and placed to the credit of the part of the second part, to be expended only upon the order of the party of the second part, countersigned by the authorized representative of the party of the first part.

Finally, it is mutually agreed that the party of the second part may, from time to time, draw for his personal use such proportion of that part of the lump sum herein provided, which is free from penalty, as the work which has been completed bears to the total amount of the work which is to be performed, but no other money or moneys will be paid to the party of the second part except through the bank, as herein above provided, until the completion of the contract and its final acceptance by the party of the first part.

The essentials of a contract of this sort are: (1) the assumption of as much of the risk as possible by the State, (2) the assumption by the State of the burden of financing the work to be done and, finally, the placing of the contractor in a position where his interests will favor the economical and careful management of the work which he undertakes. In the new form of contract the first and the third of these conditions are secured by the quite generally understood Massachusetts system of dividing both the risk and the profit with the contractor. But when the question of assisting in the financing of projects came up for discussion, it appeared at once that the South Dakota laws would not permit direct payments in money even for labor used under the new contract but required that all state bills be paid by warrant. At best such a system is slow and while not wholly unfitted for the payment of permanent employees carried over long periods of time, is notoriously ill adapted to the payment of labor during times like the present. Moreover, the laws of the state do not permit the payment of the full value of the work done on a contract till the contract is completed. It was, therefore, impossible for the state to pay direct all bills for labor and materials. However to avoid the difficulties as much as possible as well as to control absolutely the payment of laborers and the payment for all materials used, and in order to give some financial assistance, it was decided that on contracts of this kind the contractor would be required to make an initial deposit at a satisfactory bank, which deposit would be used in starting the work. As this money so deposited would be withdrawn only for the payment of labor and material under the authorization of the Highway Engineer its expenditure could be readily controlled. Moreover in this way the state laws providing that the full value of the work done can not be paid till the contract is completed are readily complied with and, at the same time, the contractor is called on for no financial outlay in excess of his original deposit.

To make the contract clearer the following definitions were added to the regular form of proposal:

[illegible] employed in the actual execution of this contract.

Under this heading will also be included teams, whether employed with, or without driver.

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*Usually from [illegible] per cent to [illegible] per cent of total cost.

†Usually one-half of lump sum above referred to.

‡Usually 10 per cent of total bid.

The term MATERIALS, as used in this proposal, shall include all materials authorized, purchased for and used on this work, together with fuel, gasoline, oil, etc., used in operating machinery used on the work and the cost of repairing breakages which occur in the performance of this contract.

As an indication of how this contract will work out when it is fully understood by the contractors, the following bid, entered at the letting above referred to, is of interest:

| | Regular form of contract. | New form of contract. |
|---|---|---|
| For 3 miles of pavement 18 ft. wide— | | |
| Concrete | $73,022.42 | $71,657.91 |
| Bituminous macadam | 63,622.83 | 58,736.32 |

It is hoped that when fully understood by all concerned, both the State and the contractors will gain by the new form of contract.

## Enamel Painting of Street Cars

The Union Traction Co. of Indiana was among the first to try out enamel painting, and perhaps among the first to adopt it as standard. Through a long series of tests and careful watching in the application of the enamel processes of painting the mechanical department of the company was satisfied with the results and is now using it exclusively on interurban city and suburban cars.

The company was confronted with the necessity of speeding up production and offsetting the shortage of labor, and at one time tried spraying its cars. This method was abandoned on account of the mist from the paint; while invisible at a distance of some 20 ft. away from the car, yet it was in the atmosphere and other workmen would breathe it, and inasmuch as it would have required considerable expenditure to fit up a room or building where this process might have proved successful, and being a game of chance, the company could not look upon the idea with any further favor. This experience, however, should not condemn the process as it may have considerable merit when proper provisions can be made to take care of it.

The enamel process, states Electric Traction, has been found to have a particular advantage in retaining its gloss, whereas, with the old varnish process the luster was quickly lost.

At first it was hard to become accustomed to a substitute for gold or silver leaf, as the case might be. However, it was not long before every one was equally well pleased with the black and yellow enamel used for lettering, numbering and stripping.

Another thing which was eliminated was the striping of the cars on the outside and inside. No more of this is done than is absolutely compulsory to keep the cars from having a somber appearance, and after becoming accustomed to cars with the absence of striping and other frills, it is really surprising how well the work looks. It is quite apparent that the idea of striping and scrolling as a necessity was merely an imaginary whim.

**Quinine as Malaria Preventive.**—Dr. R. C. Derivaux, medical officer in charge of malarial investigation of the U. S. Public Health Service, in his recent publication dealing with a quinine immunization experment on a number of families living on large plantations, states that at Lake Village, Ark., quinine was given 237 persons for immunization and a reduction of 64.45 per cent obtained as ascertained by repeated parasite index examinations. This demonstration was carried on jointly by the International Health Board and the U. S. Public Health Service.

## Method of Keying and Joining Sections of Government Concrete Dam at Troy, N. Y.

A novel method of keying and joining the sections was employed in the construction of the recently completed Government lock and dam on the Hudson River at Troy, N. Y. The methods of keying the blocks are described by Mr. Frank P. Fifer, Junior Engineer, in July-August Professional Memoirs, from which the matter following is taken:

The type of vertical keys used between sections in the bulkhead and abutments of the dam at Troy consisted of V-shaped grooves. This V type of key was also used in the monoliths of the dam proper for that part of the structure below the elevation of the apron, in addition to which the up and down-stream halves of each section were set at an angle to each other, thus making a V-shaped joint of the whole face. For that part of the dam from the elevation of the apron to the crest, a key consisting of a series of waves or curves was adopted. A plan view of this type of joint, together with a typical section of the west arm of the dam, is shown in Fig. 1. The east arm section is similar in outline, the crest being 2 ft. lower in elevation, and similar joints were used in it.

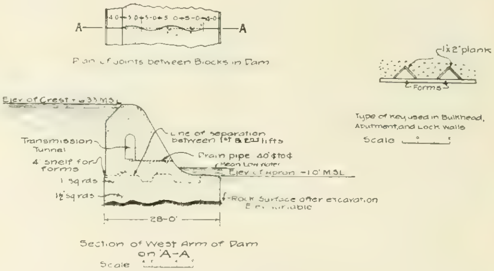

A
A
Plan of Joints between Blocks in Dam
1x2" plank
Forms
Type of key used in Bulkhead, Abutment, and Lock walls
Scale
Elev of Crest
Transmission Tunnel
4' shelf for forms
1 sq rds
1½" sq rds
Line of separation between 1st & 2nd lifts
Drain pipe 40' ¢ to ¢
Mean Low Water
Elev of Apron -1.0' MSL
Rock Surface after excavation Elev variable
28-0'
Section of West Arm of Dam on A-A
Scale

Fig. 1.—Plan View of Troy Dam Showing Method of Keying the Sections.

The curve type of joint secures a maximum effectiveness with a minimum cost in construction. Any other joint employing projections of the V-type or otherwise, would require for the same effectiveness a very large number of pieces, requiring much handling in placing and removing them at each joint, besides entailing some breakage. The bonding shown being integral with the form itself avoids the extra work, and is ready for use as soon as the form is secured.

The sections of the dam were placed in two lifts. The first lift extended from the prepared rock surface to the top of the apron. This foundation course was anchored to the rock surface by 1½-in. square rods, 10 ft. long, slanting downstream at an angle of 45°, spaced 10 ft. on centers, and are grouted about 5 ft. into solid rock. The second lift extends from the top of the apron to the crest of the dam. The bond between the two lifts is secured by making the line of separation between them a series of knobs and depressions. In addition to the bonding, 1 in. square rods were placed on a 45° downstream slant, the ends of the rods being embedded to an equal depth in each lift. These rods are spaced about 8 ft. center, and are about 8 ft. long. They were simply stuck into the green concrete of the foundation.

# Selecting, Forging and Tempering Drill Bits and Drill Steel

In our issues of Jan. 16 and March 20, 1918, we reprinted from the Engineering and Mining Journal an excellent article by Geo. H. Gilman, Chief Engineer of the Pneumatic Drill and Channeler Department of the Sullivan Machinery Co. on the proper shape of drill bits and their development. In another issue of the above mentioned journal Mr. Gilman discussed the selection, forging and tempering of the bits and steel, and this matter is reprinted below.

**Importance of Quality of Steel.**—Too much importance can not be attached to the problem of determining the quality of drill steel that is best suited for the ground. The best drill steel is not necessarily the highest priced, nor is a cheap steel the best for all conditions. In general, it may be said that the best steel to employ for a fixed set of conditions is the steel that will withstand the duty imposed upon it without undue breakage and will withstand the abrasive action of the rock with the least amount of wear.

Hollow drill steel, which is now generally used throughout the United States in combination with hammer rock drills embodying an air or water jet for the purpose of ejecting the sludge or rock cuttings from the bottom of the drill hole, is a comparatively new departure in steel making, and the manufacturers have experienced some difficulty in meeting the requirements, owing chiefly to the fact that the hole throughout the length of the bar introduces (especially in the high-carbon steel) difficulties of manufacture that have not been easy to overcome; and for this reason it is a generally accepted fact that hollow drill steel is more susceptible to breakage than solid steel of corresponding sectional area. However, there are now on the market many excellent hollow drill steels that may be procured in a great variety of shapes and sizes.

The chemical composition of drill steel is a matter that has been subjected to a great deal of experiment by the drill-steel manufacturers, the mining industry and the manufacturers of rock drills. It is an accepted fact that steel of a low carbon content will withstand more abuse by the blacksmith and lends itself more readily to welding than steel embodying a greater percentage of carbon; on the other hand, it has been determined by experience covering a great many years that the higher carbon steel will better withstand the vibratory shocks to which it is subjected in hammer-drill service, and furthermore, the cutting bit, although requiring more care in the working and tempering, may be made to last much longer than is possible with the lower carbon steel.

The following specifications for straight carbon hollow drill steel to meet average conditions of ground and air pressure conform with present-day practice:

CHEMICAL COMPOSITION

[illegible]

The forging heat of this steel should not be higher than 1,600° F. The quenching heat should be approximately 1,300° F. (critical or decalescence point). To secure this result the hardening furnace should be set to secure a heat of from 1,420° F. to 1,440° F.

The following specifications for drill steel as applied to workmanship of the bar stock are fair and reasonable to both the steel user and to the manufacturer.

[illegible]

[illegible] out the entire length. It must not exceed in area that of the maximum limit, and in the case of the hole being elliptical the long diameter must not exceed the diameter of the maximum limit plus 1/16 inch. The hole must not be more than 1/32 inch off center from the axis of the bar, and sharp corners [illegible]

**The Drill-Steel Sharpening Shop.**—No man on the job deserves more consideration than the drill-steel blacksmith, for upon him depends in a great measure the entire success of drilling. A few minutes' carelessness by a blacksmith may undo many days' work of a careful steelmaker. Underheat in hardening naturally results in a soft drill steel, while uneven heating or heating for too short a time will result in a soft center bit with danger of breakage when the steel is put into service. Present-day practice is sounding the death knell of the old-style coal or coke forge for heating rock-drill steel for forging and tempering, and it is being rapidly supplanted with the gas or oil furnace, which has a great many points in its favor, chief among them the fact that it may be adjusted to approximately maintain the proper temperature in the heating chamber and thus obviate over-heated or burnt drill steel.

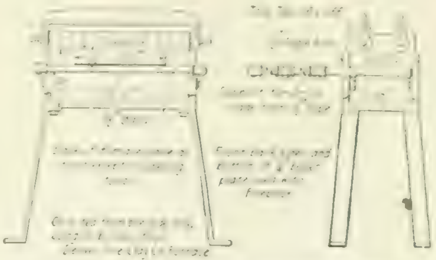


Fig. 1—Oil Burning Drill Heating Furnace

A word of caution should be introduced against the common practice of allowing the bits to remain in the furnace longer than is necessary to bring the heat up slowly and uniformly to the desired temperature, which in practice is commonly termed "soaking." This has a tendency to open the grain of the metal by enlarging the crystals and produces brittleness. The blacksmith should handle his steel in rotation by advancing each steel one step nearer the point of withdrawal when a new drill is inserted.

The furnace is preferably constructed with baffle plates or surfaces to insure the maximum heat of the blast being directed against or over the drill bit just prior to the point at which it is withdrawn from the fire. The number of steels that can be heated in the furnace at one time is determined by the time required to bring the heat of the bit up to the proper point and the speed at which it is withdrawn for forging or tempering. It is desirable to both forge and temper drill steel on the rising heat, which necessitates the steel being withdrawn from the furnace the instant the required heat is obtained.

Gas as fuel is recommended where it is accessible and cheap, as it is the cleanest and costs least for installing. If oil is used, it is desirable to have the oil-storage tank below the level of the burner, as the fire risk is lessened. A satisfactory grade of fuel oil may be procured at current prices ranging from 3 to 4 ct. per gallon.

In isolated districts a great many of the mine blacksmith shops are equipped with home-made furnaces, the burner only being purchased outside. A sketch of such a furnace which may be made at comparatively slight expense with equipment to be found in the average smith's shop is shown in Fig. 1. If a pyrometer is used for determining and checking the heating furnace a base-metal outfit is recommended on account of its simplicity and the fact that its upkeep is slight. The pyrometer should be checked periodically. If the base-metal couple is used, one of the fire ends can be kept as a standard and the fire end in daily use compared with this standard. Each month or so a new fire end can be used for the standard and the old standard put in daily use. The indicator or galvanometer should be adjusted daily for the zero reading. If the temperature of the cold junction of the fire end is determined with an ordinary thermometer, the indicator can be adjusted to this temperature.

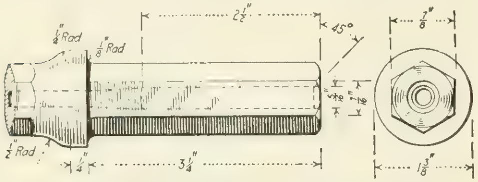


Fig. 2.—Standard ⅞-in. Hexagon Collared Drill Shank for Rotators.

For drill steel of the carbon content specified, the forging heat should not exceed 1,600° F. The forging operation should not be continued after the steel fades from a good red color, as working a steel cold (below its critical range) distorts the refined structure and tends to produce brittleness. It is better to reheat the steel to finish the forging operation than to chance a bit or shank breaking underground.

Too much emphasis cannot be placed upon the desirability of forging the bit and shank end of the drill steel by subjecting it to percussive action instead of squeezing the part into shape on the principle of the bulldozer. Drill making machines are now on the market utilizing the hammer blow for both upsetting and swaging. This method approaches more closely the results secured from hand-sharpening, which blacksmiths know is advantageous to the standing-up qualities of the bit. It furthermore permits the forging operation to be done at a comparatively low heat, as the conductivity of a rapidly reciprocating swage hammer has been found to be considerably less than that of a squeezing die.

For all hollow drill shanks equipped with a collar or lugs, the length from the shoulder to the striking end should not be more than 1/16 in. over or under the specified size, and all transverse dimensions should not vary more than 1/64 in. in either direction from the size specified. (See Figs. 2 and 3.) The striking end should be kept square and smooth, with both the inner and outer edges slightly rounded. The hole in the shank for the reception of the water tube should invariably be kept central and open to the size specified, for a distance of from 3 to 3½ in. from the tip. This hole in the smaller sizes of hollow drill steel should not be less than 3/16 in. and in the larger sizes, ⅜ in.; otherwise a great deal of trouble will be experienced by broken water tubes.

**Device for Keeping Holes in Shank and Bit Open.**—For large installations it is recommended that a pneumatic punch be provided for punching out the hole in both the shank and bit end during the forging operation. A number of successful devices have been developed for the purpose. A sketch of such a pneumatic punch is shown in Fig. 4, which, in general principle of design and operation, has been adopted by a number of the mining companies in the Southwest. Briefly, it consists of an air cylinder with its piston and piston rod, to the front end of which is detachably secured a taper punch of the required size. Compressed air is admitted to the front and rear piston chambers by a four-way plug valve under the hand control of the operator. Directly at the rear of the air cylinder is a cushion cylinder with its piston attached to the extension piston rod of the air cylinder. This cylinder is filled with oil, which is displaced from one end to the other through a small bypass connection. Forward of the air cylinder is a clamping device with suitable gripping jaws for the drill steel. This may be made hand-operative or equipped with an air cylinder and piston connected by a toggle with jaws, which assists materially in minimizing the manual operation. With an apparatus of this kind steel may be punched satisfactorily while hot, in from 4 to 5 seconds.

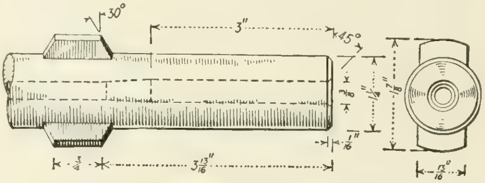


Fig. 3.—Standard Lugged Drill Shank for Mounted Hammer Drills.

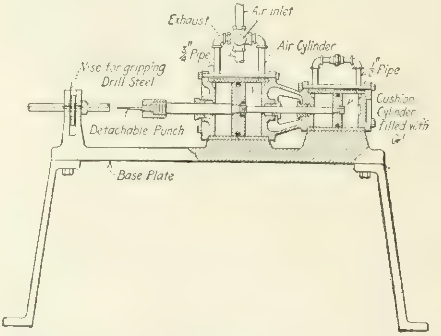


Fig. 4.—Punch for Hollow Drill Steel Bits and Shanks.

**Pyrometers and Compasses to Determine Proper Heat for Tempering.**—Whatever the grade of carbon drill steel adopted, it is essential that the critical or decalescence point be determined to assist the smith in securing and maintaining the proper heat at which the material may be hardened and tempered to the best advantage. It is called the critical point because it is the point in the temperature of the piece being heated at which a change takes place in the structure of the steel due to the carbon being dissolved. It is the point below which steel will not harden when quenched, and by coincidence it is the point at which the steel loses its magnetism. For the purpose of illustration, take a bar of drill steel about 10 in. long and nick it in 6 or 8 places spaced equidistant, to make breaking easier. Put one end in the furnace and heat it to nearly a white heat, letting the heat gradually run out to a dull red at the opposite end of the test piece and then quench it in cold water. Now break the piece at each nicked place, and it will be found that the fracture that is closest and finest grained was nearest to or at the critical point. A skilled smith may thus determine this point by experiment and gage the heat by taking note of the color, but this method is unreliable unless a check is provided, for oftentime the eye gets "off color," being influenced by the degree of surrounding light and the physical condition of the operator. It may be determined by means of the pyrometer, because when the steel reaches the critical point, it absorbs an abnormally large amount of heat. For instance, if we were to insert a pyrometer into a piece of steel being heated in a furnace, the temperature would be found to rise at a uniform rate until the critical point is reached, when its rising temperature is suddenly halted by the physical and chemical changes that take place in the steel, which cause it to absorb a certain amount of heat energy. In cooling, this condition is just reversed and a piece of steel cooled through the critical point will be found to give out a considerable quantity of heat. While the pyrometer method is reliable, the following, which may be adopted as a check, is perhaps more practical for the average mine smith.

A small pocket compass, preferably with a jeweled needle and stop, which may be procured in almost any jewelry or hardware store at nominal cost, and a pair of brass or other nonmagnetic tongs are the only essentials. This compass should be set upon a wooden stool in close proximity to the forge and in such a position that the natural swing of the test piece back and forth, when testing, will be in a plane at right angles to the needle. In other words, the test piece being hardened should be swung, using the brass tongs, east and west. By passing the test piece forward and backward close to the compass, the magnetism of the metal will cause the needle to be deflected first one way then the other and will continue to deflect the needle until the proper heat for quenching has been obtained. The right heat is reached when the material loses its magnetism. It does not follow, if the needle remains stationary the first time you test, that the heat is right, because after the material has reached a certain degree of heat the magnetism leaves the steel, so there is no influence on the needle and it may be too hot. Different grades of drill steel having different carbon content require different degrees of heat. The magnetism leaves the steel at that degree of heat corresponding to the carbon content in the steel, and in every case this is the proper heat for dipping. After testing, the smith may, by remembering the color, give the bit a corresponding heat, quench it in the bath to harden it and temper it by subsequently subjecting the cutting end to the proper heat, by drawing the temper required to give the bit the necessary toughness for the work.

For tempering the finishing bit, it should be heated slowly and uniformly until the critical point is reached and then quenched in the bath, in which provision may be made for automatically drawing the temper.

While the critical point in the heating of carbon steel does at all times indicate the degree of heat at which the steel may be quenched to the best advantage, it must be borne in mind that there will be a rapid drop in temperature of the heated steel during the time period required to transfer it from the heating furnace to the quenching bath; and in order to insure the steel being quenched at the critical point, it should be heated to approximately 100° F. higher before being removed from the furnace.

As the striking end of hollow drill steel for hammer drills is usually equipped with lugs or a collar to properly position the steel in the path of the piston hammer, it is desirable to subject the shank end, for a distance of from 2 to 2½ in. below the lugs or collar, to an oil treatment in order to provide for toughness and to make the angular section through which the rotary motion of the drill chuck is transmitted to the drill steel as wear-resisting as possible. To accomplish this, heat the shank slightly above the critical point, remove from the furnace and dip the tip end in a receptacle containing several pounds of cyanide of potassium, then plunge in oil, letting it remain in the oil until cold.

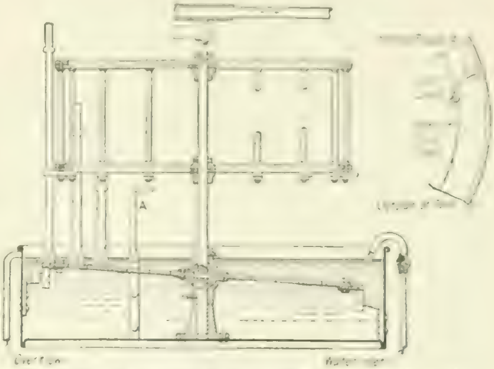


Fig. 5—The Homestake Quenching Tank for Drill Steel

For holding the oil a quenching tank will be required equipped with a grate bottom placed 2 or 3 in. above the bottom of the tank. This will prevent the steel from coming in contact with dirt or sediment in the bottom and will serve to eliminate "soft-spot" trouble. A great many devices for quenching and drawing the temper of rock-drill bits automatically have been and are being used successfully, but a device similar to that adopted by the Homestake Gold Mining Co. is worthy of consideration for average mine and contract conditions. Fig. 5 shows a diagrammatic sketch of this apparatus.

This consists of a metal tank partly filled with running water in which is submerged a revolvable perforated disk set at an angle with respect to the surface of the water. From this disk a skeleton framework is provided for supporting nonpositively locking the drill steel in position, which is disengaged by a stationary knock-off lever when the steel has been tempered for service. For hardening and tempering the drill bit, the steel is removed from the heating furnace when the critical point has been reached and the bit end is immediately quenched by placing it in a vertical position on the outer edge of the revolving disk and at the point which is nearest the surface of the water, it being locked in this position by a spring latch. This disk is made to revolve slowly and continuously, thus causing the drill bit to be submerged gradually in the bath (which is in a state of agitation) until it reaches the point diametrically opposite that at which it was positioned. Then it is gradually raised from the bath until it is automatically disengaged by the knock-off lever, it having traveled through approximately 315° of a circular path. A number of drill steels may be mounted on the disk, depending upon the number of vertical supports with which it is provided.

This method of quenching and tempering automatically possesses many advantages, chief among which is that it insures uniformity. The apparatus is flexible, and the maximum and minimum depth of submersion and the speed at which the disk revolves may be varied to suit the requirement. Owing to the gradual submersion of the bit, there is a blending from the hard to the untempered portion, which reduces to a minimum the liability of breakage.

**Inspection of Drills Before Leaving Shop.**—It is excellent practice to inspect each drill steel subsequent to the tempering operation and prior to the transportation of the steel from the shop to the drills. It should be the duty of the inspector to see to it that each piece of steel comes within the permissible limits that may be established. He should make sure—

That the drill steel is straight and that the bit and shank are formed in alignment with the steel body;

That the shank is of the proper length and shape;

That the lugs or collar at the base of the shank are of the proper diameter and length;

That the hole throughout the steel is of the proper size and free from obstruction;

That the striking end of the shank is flat and square, with the inner and outer edges slightly rounded;

That the bit is of the proper shape, with the cutting and reaming edges formed full and to the required size;

That the gage of the bit is of the correct size for the length of the steel;

That the reaming edges of the bit are concentric with the axis of the steel;

That the angle of the reaming side corresponds to the standard that may be established for the existing conditions;

That there are no sharp corners at the shoulder where the bit blends into the steel body;

That the drill steel is free from cracks and other imperfections which might result in breakage when put into service;

That the steels are of the proper length to correspond with the established length of steel change.

The object of the smithshop foreman should not be to see how many drill steels he can put through the forge or drill-sharpening machine, but to see how many correctly shaped, gaged, tempered and sorted drill steels he can turn out per unit of time.

For inspecting the shanks, a hollow gage of the correct length with its inside diameter of such a size and shape that it may be readily passed over the shank body and lug is recommended.

For inspecting bits, a limit ring gage about 1½ in. long for each size of bit may be used to advantage. The bore of the gage should be slightly tapered in order that the larger diameter at one end may determine the maximum, and the smaller diameter of the other end the minimum permissible for each size of bit. The method employed when inspecting is to place the large end of the gage over the finished bit, which, if it enters but does not go through, will indicate that the gage diameter of the bit is within the permissible limits. It will also determine if the reaming edges are correctly formed. For convenience the ring gage may be made with a segment of its wall cut away, thus providing a means for the inspector to determine if the required clearance is provided at the rear of the reaming edge.

Remember that great importance is attached to having the drill bit true in every particular so that the shank is in a straight line with the axis of the steel and the outside edges of the bit are in a true circle.

## How the $500,000,000 for Railway Work Will Be Spent

Of the $500,000,000 authorized by Director General of Transportation William McAdoo for expenditure this year for railroad improvements and extensions only $88,500,000 had been spent up to July 1. Of the amount $18,632,000 went for additional yard tracks, sidings and industrial tracks, $12,000,000 for main tracks, $8,650,000 for freight and passenger stations and office buildings, and $8,150,000 for bridges, trestles and culverts. The apportionment of the half billion dollars among the railroads was given in our July 17 issue. The schedule of the various classes of work to be covered by this expenditure follows:

| | |
|---|---|
| Widening cuts and fills, filling trestles, etc. | $ 5,116,000 |
| Ballasting | 9,379,000 |
| Rails and other track material | 31,512,000 |
| Bridges, trestles and culverts | 38,254,000 |
| Tunnel and subway improvements | 2,185,000 |
| Track elevations or depressions | 6,717,000 |
| Elimination of grade crossings | 7,691,000 |
| Grade crossing and crossing signals | 647,000 |
| Additional main tracks | 47,118,000 |
| Additional yard tracks, sidings and industry tracks | 99,231,000 |
| Changes of grade or alignment | 6,363,000 |
| Signals or interlocking plants | 11,236,000 |
| Telegraph and telephone lines | 5,131,000 |
| Roadway machinery and tools | 955,000 |
| Section houses and other roadway buildings | 1,309,000 |
| Fences and snowsheds, right of way, snow or sand fences | 817,000 |
| Freight and passenger stations, office buildings, etc. | 23,510,000 |
| Hotels and restaurants | 199,000 |
| Fuel stations and appurtenances | 6,197,000 |
| Water stations and appurtenances | 13,520,000 |
| Shop buildings, enginehouses and appurtenances | 62,801,000 |
| Shop machinery and tools | 10,723,000 |
| Electric power plants, substations, transmission lines, etc. | 10,796,000 |
| Wharves and docks | 3,236,000 |
| Coal and ore wharves | 7,024,000 |
| Grain elevators and storage warehouses | 2,954,000 |
| Real estate | 3,432,000 |
| Assessments for public improvements | 1,182,000 |
| All other improvements | 28,113,000 |

## Clam Shell Bucket in Snow Removal Work

A clam shell bucket handled by a self-propelled derrick car was employed very successfully last January by the New York Central R. R. in removing snow from a highway intersection at the Gibson, Ind., yard. The entire area had to be cleared which if done by hand shoveling would have involved carrying the snow in shovels a considerable distance. It is stated that the bucket and derrick in 1 hour removed as much snow as 30 men with hand shovels would have done in 10 hours.

# Levee Settlement: Cause and Remedy

The recent frequent cases of levee settlement on certain parts of the Mississippi has brought to the attention of the authorities a problem in levee construction, which though not altogether unknown in the more remote past, has not until the last 4 or 5 years reached the proportions which call for precautions to prevent or minimize its recurrence. A study of this sinking or subsiding tendency has been made by the Board of State Engineers of Louisiana, and in their last annual report some of their conclusions are given. The notes following are taken from this report.

It is the exception rather than the rule, that new levees can, as a general proposition, be built and the amount of settlement be limited to what may reasonably be expected from the natural shrinkage taking place in newly-constructed earthwork. This tendency of reaching what seems to be the limit of the supporting power of the soil has been particularly noticeable in levee construction below New Orleans.

Observations of numerous occurrences of this kind in widely different localities have pointed to the existence of some relation between the natural elevation of the ground upon which the levee is built, and the net height of the levee it will sustain. It has been noticed that where the ground surface is, for example, 5 ft. above the Gulf Level, it will carry a levee 9 ft. high, but not one 11 ft. high. Likewise if the ground surface is, say, 3 to 4 ft. above Gulf Level, it will barely sustain a levee 6 ft. high.

It has also been noticed that these subsidences occur more often in instances where levees are built by machinery than where built by wheel-barrows or teams, and this fact has led to the opinion that the probable cause of the failure of the foundation is the deeper pit excavation made by the levee-building machine. This opinion is based on the assumption that underlying the foundation of the levee are strata of semi-liquid material or watery slush, and this material is displaced by one or the other of the following causes:

1. These strata are tapped in digging the pit, and the slushy material oozes out or flows out into the pit, leaving a void under the foundation of the levee which is filled by the superincumbent embankment crushing through suddenly; or,

2. The pits, after having been stripped of what may be termed the over-burden of deposit have insufficient thickness on the bottom to resist the upward pressure of this semi-fluid material and in this way permit its displacement from under the levee by pushing up the bottom of the pits, and is accompanied by a gradual slow subsidence of the adjacent embankment.

It has also been observed that where search ditches or muck ditches have been dug near the center line of the levee, that this has contributed to the subsiding of a portion of the levee, if not of the whole length, and the larger the search ditch or much ditch the greater the degree of subsidence. Instances of this kind have occurred where the new levee was practically a turn-over job and did not involve digging of pits exceeding 4 ft. in depth.

Still another interesting observation was the case of a new levee located in a sugar cane field, a part of which was built with a 20-ft. berme, and a part with a 45-ft. berme, and which, after construction, subsided to the point where the change to a wider berme was made; no subsidence taking place on the wider berme portion of the levee, although the same height and section of levee, same material and same method of construction prevailed in both cases.

The conclusions reached from the study and observation of this subject of subsiding levees as limited to the instances occurring principally on that part of the Mississippi River below New Orleans, point to the advisability in the future where subsidences are expected, to adopting the following preventive measures:

(a) The depth of the pit to be limited so that the bottom will not be below Gulf Level.

(b) The muck ditch to be eliminated or to be located at or near the toe of the slope.

(c) A greater width of berme to be prescribed than has been the practice heretofore.

As regards that part of the levee system above New Orleans, on account of the relatively higher elevations of the ground surfaces and the corresponding higher bearing power of the soils, this trouble of subsiding levees was not generally encountered until the construction began of new levees on retired locations and built to the increased prevailing Mississippi River Commission grades. The increased elevation of the levee grade and the naturally lower elevation of the ground surface 500 to 600 ft. in the rear of the existing levee, are accountable, in a majority of instances, for an increased net height of the levee from 3 to 4 ft. So that in the caving banks between New Orleans and Baton Rouge, a levee with a net height of 20 to 21 ft. is the usual requirement, and above Baton Rouge, these heights are sometimes slightly exceeded.

The weight of an earthen embankment of this height would be approximately 1,800 lb. to 2,000 lb. per square foot for such part of the embankment as is 5 ft. on either side of the center line. This does not exceed the theoretical safe supporting limit of the soil upon which the embankment is built as is evidenced by the stability of brick chimneys, brick walls, and other structures in the immediate locality. But Professor Rankin's safe load of $\frac{1}{3}$ to to $1\frac{2}{3}$ tons per square foot, and Professor Baker's recommended safe load of $1\frac{1}{2}$ to 2 tons per square foot for ordinary clay foundations do not pre-suppose the presence of pits 10 ft. or more in depth within 200 ft. of the point of application of the load.

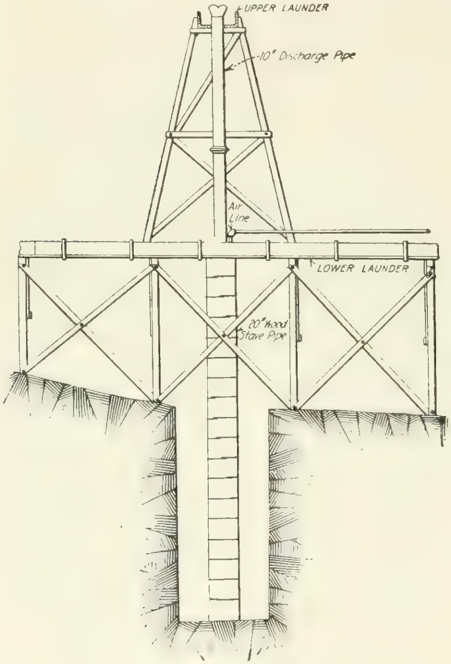
So that again, the conclusion forces itself that deep pits are responsible for many of the occurrences of this nature on the upper coast, as well as on the lower coast. That this deduction is correct is proven conversely by the fact that the most obstinate cases of subsiding levees or sinking levees have been corrected by "loading the berme," or "loading the pit" after which the levee is easily brought to grade. This, however, is a very costly operation. But specifying shallow pits is also a sure way of increasing the cost of levee work.

Since it is certain that we shall continue to have subsiding or sinking levees in the future, it follows that the determination of the economical men between the costly curative method of dealing with subsidences after they occur, and the costly preventive method suggested above, is a subject inviting the careful consideration and thought of all levee building authorities.

# Economic Air Lift for Handling Sand or Screenings

An interesting description of an economic air lift employed by a copper company for handling tailings from its mill appeared in a recent issue of the Engineering and Mining Journal. In as much as this device could be similarly used for elevating sand, gravel, etc., the article is reprinted below:

Tailings from the mill of one of the largest copper companies in the Southwest are brought to a consistency of 4 or 5 parts of liquid to one of solid and allowed to flow by gravity through launders for about a mile where they then have to be lifted from 15 to 30 ft. and carried over a dam into a settling pond or dump. About 7,000 gal. per minute of this mixture is handled, and three 10-in. centrifugal sand pumps, direct-connected to 150-HP. motors, were previously used. This method was found to be very expensive, as the tailings were sharp and cut out the casings and impellers of the pumps very rapidly, the average life of a pump not exceeding four days of continuous operation. Large motors were necessary, as the efficiency of the pumps dropped readily to a low point as wear occurred.



Air Lift Used by Copper Company for Handling Tailings.

To obviate these difficulties, an air-lift system was installed and has proved a solution of the problem. At various points in the lower launder, openings were made discharging each into a 20-in. wood-stave pipe, which was set in a pit a sufficient depth to give proper submergence and closed at the lower end. Inside of this a 10-in. discharge pipe, fitted with a footpiece, is placed, through which air is introduced at the bottom and which discharges directly into the upper launder. This pipe has no bends and no obstructions inside, so very little wear can occur and renewal will be practically unnecessary. Three of these installations are able to handle the maximum tonnage. A separate compressor, driven by a 40-HP. motor, is used for each air lift, although all three could easily be handled from a central plant if local conditions made it desirable. Compressors and motors are housed and require little attention. Operating costs and repairs have been cut to a small fraction of what they were with sand pumps, and the inconvenience of frequent shut-downs is eliminated.

# A Comparison of Pile Bearing Formulas*

By C. E. NICHOLS.

The purpose of this article is to point out briefly what progress past study and discussion has made toward establishing standards for judging the supporting power of piles driven by modern methods and appliances; to indicate the limitations of the formulas in common use for this purpose; and to suggest certain lines along which our experience and knowledge of the subject can be increased. Consideration is given to formulas used in driving both wood and concrete piles, and to the three most common methods of driving, namely, by means of the "drop hammer," the "single-acting steam hammer," and the "double-acting steam hammer."

The Wellington or Engineering News formula (published in 1888) is: $L = \frac{2wh}{s + C}$ in which

$L$ = safe bearing capacity in lb. (Factor of safety = 6.)
$w$ = weight of falling hammer in lb.
$h$ = height of fall in ft.
$s$ = penetration per blow in inches for last few blows.
$C$ = Constant depending primarily upon the type of hammer used and the frequency of the blows.

This formula (with the factor of safety eliminated) is merely an equation of the average resistance to the movement of the pile through the distance of its penetration and the driving energy of the hammer falling through a certain distance; modified by making allowance (by the factor C) for the loss of energy expended in overcoming the inertia of the pile, in causing vibration, brooming and heating—of which items that of overcoming inertia is by far the largest. It is evident, then, that the selection of a value for "C" in the formula is a matter for the judgment of the engineer and it is interesting to note that in present practice when driving wood piles with drop hammers weighing from 2,000 lb. to 3,000 lb. and falling 10 to 15 ft. each blow, the value of $C = 1$ which is almost universally used is the same as originally recommended by Wellington. For most pile driving work by this method no change in the value of C in this formula is warranted, but in extreme conditions, as for example the driving of very short, light piles with a heavy hammer, the engineer might well change the constant accordingly.

In the early '90's single-acting steam hammers came into use for pile driving and it was evident that the much greater frequency of the blows struck by these hammers reduced materially the amount of energy necessary to overcome inertia, and also the greater rigidity of the pile in the heavy driver leads minimized the loss in vibration. Consequently an entirely different value for C in Wellington's formula should be used for this type of hammer. Again the original recommendation is still the present practice and the formula used in this case is $L = \frac{2wh}{s + 0.1}$. Hammers of the type for which this formula is used have striking rams weighing from 3,000 lb. to 5,000 lb. falling $2\frac{1}{2}$ to $3\frac{1}{2}$ ft., and strike 40 to 80 blows per minute. It is interesting to note that the ratio of the values used for C in the formulas for drop hammers and single-acting steam hammers is approximately inversely in proportion to the ratio of the products of the weights of hammers and the number of blows struck per minute for the respective types of machines.

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*From Stone & Webster Journal.

The single-acting steam hammer is also commonly used for driving both "precast" and "built-in place" concrete piles, as well as for wood piles, and some slight controversy has arisen occasionally as to the proper formula to use as compared with that for wood piles. Some of the commercial manufacturers of concrete piles have claimed that a greater proportion of the energy of the hammer is effective in causing penetration on account of the greater rigidity and hence less vibration than with wood piles, and consequently that a relatively higher value should be allowed for loading. As a matter of fact the greater amount of energy expended in overcoming inertia probably more than balances the gain due to greater rigidity and the value of C in the Wellington formula should consequently be increased rather than decreased for concrete piles. Precast concrete piles will weigh from 5 to 8 times as much as wood piles of the same length due to the higher unit weight of the material and to the larger sectional area commonly used; while in the case of the built-in-place piles, such as the Raymond, Simplex, or Mac Arthur piles, the weight of the shells and driving cores or mandrels is sometimes more than ten times the weight of the same length of wood piles.

An additional argument for using a more conservative formula for concrete piles is that they are commonly loaded from two and a half to four times as much per mile as are the wood piles, resulting in a correspondingly smaller total number of piles required in a footing or group; so that in the event of the failure of one pile, due to injury during or after driving, the percentage of reduction in strength of the footing, or the overload on the remaining piles in the group, would be much greater than if one wood pile failed in a group of the same total bearing capacity. This argument is especially pertinent in the case of foundations for a building requiring but a few piles under each column.

One modification of the Wellington formula that has been suggested to take into account the greater inertia of concrete piles in the form (referred to later as Formulas X):

$$L = \frac{2wh}{s\left(1 + \frac{W}{w}\right)} \text{ for drop hammers, or}$$

$$L = \frac{2wh}{s\left(1 + \frac{0.1W}{w}\right)}$$

for single-acting steam hammers, where w equals the weight of the hammer and W equals the weight of the pile. These formulas however differ radically from the Wellington formula in principle, in that there is no constant involved which is independent of the amount of the penetration. These formulas would at times give higher rather than lower safe-bearing capacities than the Wellington formula. Probably a better form would be to modify only the constant "C" by the ratio of $\frac{W}{w}$ giving formulas as follows (referred to later as Formulas Y):

$$L = \frac{2wh}{s + \frac{W}{w}} \text{ for drop hammers, and } L = \frac{2wh}{s + \frac{0.1W}{w}}$$

for single-acting steam hammers.

Formulas X give somewhat lower values than the Wellington formula for capacities below 30 tons per pile, while above this limit they give materially higher values. On the other hand, formulas Y will invariably give values lower than the Wellington formula if the weight of the pile exceeds the weight of the hammer. The large reduction by this formula may seem radically conservative, but it should be remembered that the drop hammer is seldom used for concrete piles at the present day, and when it is used extreme precautions are taken to protect the head of the pile from the severe shock of the blow by means of cushions which must absorb considerable energy and increase the loss due to overcoming the inertia. Formulas X are conservative and serve their purpose up to a load of 25 tons per pile if the weight of the pile is more than twice the weight of the hammer, but outside either of these limits formulas Y are preferable.

Double-acting steam hammers (of the McKiernan-Terry type) have been used extensively for driving sheet piling, but have seldom invaded the field of bearing piles. Their use for this purpose, however, has been sufficiently frequent to vex and worry the engineers who insist upon satisfying themselves so far as possible upon the safe bearing capacity of piles upon which they purpose to erect some structure of more or less importance; and consequently some reasonably accurate formula should be established for this type of hammer or else it should be avoided entirely as a means of driving bearing piles. Only very meager data are as yet available from which to develop a consistent formula.

The form of this formula might well be that of the Wellington formula modified to suit the changed conditions, but the few authorities who have attacked the problem have apparently been for the most part disinclined to open public discussion of the subject. There seems to be no reason, however, why the general formula $L = \frac{2wh}{s + C}$ should not apply to these hammers—w in this case including the weight of the moving ram and also the average total pressure of the steam on the driving piston. The formula then would be $L = \frac{2(w + Ap)h}{s + C}$ with nothing open to question but the proper values of p and C. In this formula A = the area of driving piston, p = the average steam unit pressure on the piston throughout its stroke, and the other symbols the same as in the Wellington formula.

What little data are available show that p is about one-half the gage pressure at the hammer and should certainly not be taken as over one-half the pressure recorded by a gage as near the hammer as it can [illegible]

Regarding the value of C, two prime factors are in evidence: the frequency with which the blows are struck is from two and a half to three times that of the single-acting steam hammer; the weight of the moving ram (generally less than 1,000 lb.) is only one-fourth to one-sixth that of the single-acting type. On that basis, and from the premise that the value of C is largely a question of the energy exerted in overcoming inertia, it would appear that C in this case should be two to three times its value for the single-acting hammer, and that a conservative figure would be $C = 0.3$.

The formula $L = \frac{2h(w + Ap)}{s + 0.3}$ has been checked by the author in the case of a few piles driven with a No. 7 McKiernan-Terry hammer and which compared favorably with similar piles driven at the same location with a 3,000-lb. single-acting Vulcan hammer. This check is not in itself sufficient to establish the absolute accuracy of the formula, but does indicate that it is safe and is reasonably accurate for conditions similar to those for which it was tested.

It is clear that no simple formula can be accurate for all conditions of pile driving involving piles of different sizes, lengths and materials, soils of varying descriptions, and pile drivers of endless sorts with light or heavy hammers and with long or short drops. A formula can at best be but a guide to the engineer who must develop ability to analyze and weigh his data carefully in the light of what his formula indicates, and give his judgment as determined by all the conditions involved. The engineer who relies solely upon a pile formula taken from a handbook or from a technical magazine article is hardly fit to be a recorder of pile driving data—much less to be an engineer in responsible charge of foundation work.

Much more can be done in the way of establishing the reliability of and the proper use of pile formulas than has been done in the past. The careful recording of tests, the comparison of tests with formula values, and the publishing of or making available this data to other engineers will in time more nearly standardize pile-driving practice for a great many localities and general soil conditions where considerable pile driving is constantly going on. Also a little additional expenditure of time and money will frequently enable engineers to check the consistency of one formula or constant with another by the comparison and test of a few piles of different types or driven by hammers of different types at the same location and under like general conditions. A greater co-operation along this line between owners, engineers and contractors would be of inestimable value to all concerned and particularly to other owners, engineers and contractors who may follow.

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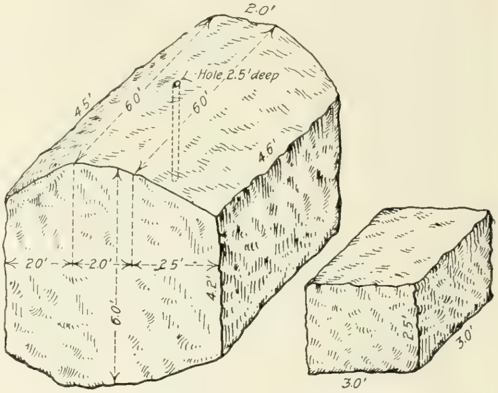
**Strength of 100-Year-Old Submerged Spruce Timbers.**—Tests of spruce timbers that had been under water for nearly 100 years, made for the U. S. Corps of Engineers, showed a tensile strength of from 7,000 to 12,000 lb. per square inch. The tensile strength of new spruce, according to Trautwine is 10,000 lb. per square inch. The timbers were removed from a stone filled crib dam built in 1823 at Troy, N. Y., for the old Erie Canal.

# Chamber Blasting, Cable Drilling and Block-holing Methods

Two methods of preparing the ground to receive the blasting charges are employed in the work of excavating the ore in the Copper Mountain deposit at Ajo, Ariz., belonging to the New Cornelia Copper Co. One method is to tunnel into the working face on a level with the floor of the shovel pit; the other method is to drill vertical holes about 6 in. in diameter with No. 14 Cyclone gasoline cable drills. An interesting description of these methods is given by Mr. S. U. Champe in a recent issue of the Mining and Scientific Press, from which the matter in this article is abstracted.

Before the blasting is done, the ground is closely examined and a careful stadia survey is made to determine the toe and crest of the working-face and the proper situation for the powder-chambers. An effort is made to ascertain the positions of the faults and also of the solid and loose material. The effect of these features on the result of the blast is anticipated. From the data thus secured a plan is drawn, and from this map a sufficient number of cross-sections is plotted to calculate the tonnage that will probably be broken by each charge of powder.



*Boulder before shot.* *Largest piece after shot.*

Diagram Showing Method of Block-Holing.

For a working basis, each pound of Trojan 40 per cent powder is taken as having sufficient strength to break four tons of ore. This, no doubt, is an underestimate of the strength of the powder, but it has proved advantageous to slightly overload the holes. This practice, to a degree, prevents the broken ore from hanging on the faces and from developing slides, which are dangerous to life and equipment, and are expensive to shoot down. In actual practice 5.44 tons of ore have been broken for each pound of powder used, including that required for "springing" or chambering the churn-drill holes. This figure was determined from accumulated records of the blasting of 530,600 tons of ore. The ore weighs about 160 lb. per cubic foot.

**Chamber Blasting.**—By the tunnel-method, the tunnels are driven into the face to a depth equal approximately to two-thirds the height of the ore above the powder-charge. From the main tunnels two sets of cross-cuts are made, one set at the rear of the tunnel and the other about 30 ft. back from the portal. The cross-cuts are driven to such a distance as will make the charges in the rear an equal distance apart for all tunnels. Two powder-chambers, one at each end of the cross-cut, are excavated in the back. In the front cross-cut four chambers are used. The powder-charges are placed about 6 ft. below the floor of the pit. About 20 per cent of the total amount of the powder in each tunnel is placed in the front charges. These figures apply to ideal conditions only. Allowances are made for faults, hard and loose material, height of bank, and other things, so that the amounts of powder may be proportioned accordingly. The advantages of the tunnel-system are: No springing is necessary before placing the powder-charges; the danger of premature explosions from hot walls, caused by chambering with powder is eliminated; the work can be done with less skilled labor; it is not necessary to build roads over difficult surfaces for the movement of heavy drilling machines. On the other hand, tunneling into a low bank is as expensive as tunneling into a high one. When this method is used in banks less than 50 ft. high, the cost per ton of ore broken has been found to exceed the average.

**Cable Drill Blasting.**—Churn-drill holes (6 in. diameter) are placed about 50 ft. apart and are drilled to a depth of 6 ft. below the floor of the pit. After using different methods, the mine superintendent, Fred Eckman, is now using the following procedure when chambering churn-drill holes:

1. Use 28 sticks of powder, without tamping, to blow the hole dry; that is, to drive out the water.

2. Load the hole with 25 lb. of powder and 15 ft. of tamping. This charge is to enlarge the bottom of the hole to receive the final shot for chambering.

3. Load the hole with one-tenth the amount of powder that is to be used in the blast. If the hole is to be loaded with 80 boxes of powder then use 8 boxes for the chambering shot; if 100 boxes are to be used, then 10 boxes will be required for chambering. About 40 ft. of tamping is used over the final chambering-shot. After each shot, time must be allowed for the walls of the hole to cool. Repeated tests of temperature are made by lowering a self-recording thermometer into the hole.

There are advantages in using the cable churn-drills. The work can proceed without interference to steam-shovel operations, and where the working-space is limited greater quantities of ore can be prepared for blasting than with the tunnel-method. It is not necessary to wait until the ore already shot down is removed before the work of drilling for the next blast can proceed. Churn-drills have proved exceedingly satisfactory where the working faces are not over 50 ft. high.

On account of the extreme hardness of the ore in the Ajo district, it has been found that after a depth of 40 or 50 ft. has been passed the cost per foot of hole drilled rapidly increases.

In the process of excavating the ore in Copper mountain, it was estimated that 200,000 tons of ore was broken by a single blast. This was on Feb. 28, at what is called "No. 3 hill." Seven holes were drilled with a churn-drill, each hole being 6 in. in diameter and 90 ft. deep, spaced 50 ft. apart. A total of 32 tons of 40 per cent Trojan powder was used in the blast. That includes the powder used for springing as revealed when the smoke had cleared away four minutes later.

**Block-holing.**—All block-holing at Ajo is now done with the same grade of Trojan powder. The practice is illustrated in the accompanying cut. In this particular case a block measuring approximately 6 ft. in all three dimensions was drilled in the center of one side to a depth of 2 ft. 6 in. Block-holes are loaded with 2 ounces of the granulated 40 per cent Trojan powder. A fuse split at the end, and without a detonating cap, is next inserted, after which another 2 ounces of the powder is poured in and lightly pressed down with a wooden tamping stick. The remainder of the hole is then tamped full of screened sand, and the charge is ready for shooting. In all cases the results are practically the same: the boulder immediately around the hole is completely shattered, while the lower half is split into pieces, the largest of which, in the case cited, is shown on the diagram.

Mexican labor is used for this work. One man with an Ingersoll-Rand BCR-430 jack-hammer can drill 100 holes, averaging 18 in. deep, in eight hours, making all his own air connections. These, as well as the powder men for this work, are picked men, working most of the time without the direct supervision of a foreman. The labor is very satisfactory.

The drawing shows a common size of boulder in which 4 oz. of powder is used. If, by inspection, a boulder is approximately half as large, then only 2 oz. would be used; if twice as large 8 oz. would be required, and so on. At present the powder is stored in two stone buildings, one of 200-ton capacity, the other of 100-ton capacity, both about ½ mile from the present steam shovel pits. To date this has proved ample storage capacity for the amount of reserve powder required.

## Pneumatic Tie Tampers Fitted with Pick Points Used for Widening Rock Cut

Pneumatic tie tampers fitted with bars with pick points instead of tamping bars were employed by the Pennsylvania R. R. in widening a rock cut on its line between East Liberty, Pa., and Pittsburgh. The rock removed is known as Pittsburgh shale and, while soft and having decided cleavages, is hard enough to make its removal by hand picks difficult. The local restrictions prevented the use of explosives. The work was of considerable magnitude, being 400 ft. long with a thickness ranging from 10 to 25 ft.

Rope slings to support the men and tools were attached to the fence at the top of the cut and, together with an air hose, were strung along the face of the cut. The work commenced at the top of the wall and progressed downward in shelves, each cut being made to the full depth back to the permanent face. The operator picked downward through the rock for a distance of about 8 in. and then drove the pick into the horizontal seam, breaking the rock off in layers about 6 in. thick.

The rock broke off in comparatively small pieces, which became further broken up in the downward course into gendola cars which were placed alongside the work. Plank aprons were provided to enable the spoil to be loaded into the cars with the least effort. The method of placing the slings and the loading of the material are shown in the photograph. The air supply for the tools was obtained from the supply line used in connection with the signal system.

## Small Derricks of Special Pattern Used on Lock Wall Construction at Troy

In the construction of the Government lock and dam on the Hudson River at Troy, N. Y., work on the lock was expedited by the use of two small derricks of special pattern, one for each of the two walls. The derricks had to be made very narrow so as to pass each other and at the same time they had to have a long reach so as to cover the wide foundations and the considerable height of the walls. The necessary reach was obtained by using an overhanging arm built up of channel irons.

The width of the derrick frame was 10 ft., and its length 24 ft. The mast spar is 24 ft. high, the boom was 40 ft., and the outward over-hanging arm had a reach of 16 ft. Owing to the narrow base of the derrick, ample counter weights of sand and gravel had to be used and in lifting weights on a low boom a portable guy was strung from the top of the mast. These derricks proved very successful, and to their handiness and quickness in operation much of the satisfactory progress was due. As they had been designed with a view of easy removal, they were used on several other parts of the work and when finally done with were transferred to another district for work on fortifications.

Special Type of Derrick Constructing Lock Wall.

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**Big Electric Company Operates Own Barge Line.**—A small fleet of rebuilt boats was recently placed in service as a barge line on the New York State Barge Canal by the General Electric Co. of Schenectady, N. Y. Last winter the company purchased three lake schooners. These have been altered by removing the sailing rigging and building a house with side doors to cover the deck. Portable gravity conveyors are used in loading and unloading, and both deck and hold loads may be carried. It is the purpose of the company to run these boats between Schenectady and New York, with possibly an occasional trip to Rome, where certain copper supplies are obtained. The down cargoes will consist of machinery, and the return loads will be copper and raw materials. The boats will each carry a cargo of 300 tons, and will operate independently, each being towed by a tug.

## The Opportunities for Safety Engineering in Construction Work*

By DAVID VAN SCHAACK,
President National Safety Council.

A civil engineer is perhaps the best qualified of all engineers to be a safety engineer as well, because in his work he has constantly in mind the fundamentals of safety and strength, utility and economy, which are also the fundamentals of safety engineering. In planning his work an engineer gives close attention to the methods used in its construction, and he must often consider the safety of the workmen as well as the operations to be performed, because he knows that he cannot get good construction unless the men can work in comparative safety. Every workman devotes some part of his time and attention to protecting himself against injury. The less time required for this purpose, the more there is for productive work. So a civil engineer is in fact a safety engineer without, perhaps, realizing it.

**Safety Engineering in the Industries.**—It is no exaggeration to say that within the past few years there has grown up a new branch of the engineering profession—that of safety engineering—which has already a well-defined field of usefulness in present day industries. It owes its origin to the rapid increase of organized safety work in manufacturing plants and other industrial operations, an increase which is notably evidenced by the National Safety Council's growth within 5 years from 50 members to a membership of 3,500 industrial concerns, employing upward of 6,000,000 workmen. Many concerns now employ safety engineers to devote their entire time to a thoroughly organized safety campaign, comprising the two essentials of accident prevention work, safeguarding and the education of the workmen.

The safety movement is now well beyond the experimental stage. Its value is an established fact, and it has gained such impetus that not only can there be no retrogression but failure to continue a rapid and steady advance seems impossible. Some concerns have started safety work not fully convinced that it would amount to much, of a mind that it was perhaps a passing fad, but they have soon found it to be good business. It not only produces direct savings and increases the efficiency of workmen, but it promotes the better feeling between employer and employes which is so highly desirable. It has been the history of almost every case that employers who once start an organized safety movement increase each year rather than decrease the amount of time and money given to it. The movement grows, and grows rapidly, as they see the results of their first efforts.

**Safety Engineering in Construction Work.**—What has been accomplished so widely in manufacturing plants can be done in construction work—in fact has been done. Perhaps even more can be done in construction work, because a greater need exists. Construction work as a class is one of the most hazardous. Each year it exacts a heavy toll of killed and maimed. The underlying principles of safety work apply to construction the same as to other branches of industry, and there is no doubt about the results of their application being equally satisfactory. Stated as two aphorisms, these principles are as follows:

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*Abstract of a paper presented before the Connecticut Society of Civil Engineers.

> A [illegible] of safety [illegible] construction work [illegible] operation will permit.

and

> Each person should strive to keep from injuring himself or others.

As is plainly seen, the first places responsibility on the owners, the contractors, the engineers, the superintendents and foremen, or others who share as parts of the "directing minds" of the operations. The "Hand of God" causes very few accidents. They are generally the result of somebody "taking a chance" who knew better.

The second, that "each person engaged in construction work should strive to keep from injuring himself or others" is something to be instilled into the minds of the workers. It is useless, of course, to provide good equipment if it will not be used, or give instructions for safe methods if they will not be carried out. The desire for safety must be in the minds of the foremen and workers, themselves. At first thought, it might appear as an almost hopeless task to instill into the minds of some workmen a sense of carefulness about themselves or others. But I want to say right here that such is not the case. The old copy book adage of "Self-preservation is the first law of nature" is still a moving impulse, and most workmen can be brought to note the advantages to themselves of safe equipment and safe methods. The greatest difficulty, perhaps, is with the quick, heedless type of worker who delights in scorning danger in order to "show off." This kind needs to be disciplined as well as educated. Some rules are necessary at times, but I believe the fewer the rules the better.

**Safe Methods Equipment and Education Basis of Safety Work.**—Safety work in construction is, therefore, as in other industrial fields, dependent on safe methods and equipment and on education. The importance of the first two have been recognized, while that of education has only within recent years come to be appreciated as it should. Each is dependent on the others for anything like complete fulfillment of its purpose. All are dependent upon that cordial co-operation between employer and employes which is obtainable only through organization, and this co-operation cannot well be expected from the workmen unless they have reason to believe that their employer is willing to do his full share in the joint effort which will inure to their common benefit. What and how the employer does in taking care of his part are the best tangible evidence of his good faith.

Engineers readily appreciate that accident prevention is an economic necessity. The strenuous business competition of today calls for the highest degree of efficiency if success is to be attained, and industrial accidents are such an actual and potential cause of impairment of efficiency that they cannot be ignored.

Without belittling its humanitarian side, the day has gone by when safety work was considered an humanitarian fad; the experience of employers who have undertaken it proves too plainly that it is good business. Gone by, too, is the day when its economic value was measured solely in terms of damages or compensation saved, or lessened insurance cost. Considerable as the direct cost of accidents may be, they are much more expensive to an employer through the lost time of injured men, through interruption of the work of others caused by accidents, through the waste of material and the spoiling of product by new men, through their lessened production, through the time of foremen or others diverted for their training.

Not only does safety work cut down the loss in efficiency due to accidents, but it tends to increase output. The less time a workman has to devote to avoiding injury, the more he has to give to production. And the spirit of co-operation among workmen developed by organized safety efforts is also plainly reflected in a greater interest in their work.

**Labor Turnover and Safety Work.**—Every employer knows how costly labor turnover is, how important it is to the general efficiency of his plant to keep his labor force as intact as possible. Especially is this appreciated now, when the turnover is so phenomenally large. Safety work reduces labor turnover, both directly through lessening the number of employes killed and injured and indirectly through promoting better relations between employer and employed.

The thinking employer, who takes carefully into account every single item of cost entering into the turning out of his product and who endeavors in every way to conserve his capital investment, must view with favor anything which tends to stabilize his working force. With the necessary money available, it is possible to purchase his equipment in a short time, but the creation of an efficient working force often requires years. No matter how carefully the original material is selected, it has to be readjusted, sifted out, replenished, sifted and replenished again and again, before the desired efficiency is reached. All this takes both time and real money, plenty of it. Once created, an efficient working force is not only a most valuable asset, but it represents a capital investment which is well worth all the protection that can be given it.

One of the pioneers in safety work struck the keynote when he said that the best safety device was a safe man. Another has put it that the greatest factor operating toward the prevention of accidents is not the prevention device, but the "prevention spirit." The safety slogan which has the strongest appeal to me is "get the safety habit." There is a lot of meaning in that phrase. Safety habit is but another way of spelling caution, which is the one and only preventive of so large a number of industrial accidents. The safety habit may, perhaps, not be so easy to acquire as some other habits of which we know, but it is certainly much more worth while.

I do not think I exaggerate in making the statement that promoting the safety habit, getting the men to think safety and to think it unconsciously, is the biggest thing that safety engineers have to do, and the most difficult. It is the leading feature of the general educational work which is the keynote of all successful accident prevention campaigns. Workmen do not intentionally get hurt, but ignorance and thoughtlessness are the most prolific causes of accidents, and these causes can be eliminated only through a comprehensive plan of education.

**Foremen Should Be in Full Sympathy with Safety Work.**—The one thing to do is to create an atmosphere of safety, if I may so describe it, and the more the foremen and workers participate in creating it, the better the results will be. The size of the job in no way governs the degree of safety that can or should be attained. The underlying principles are just as much needed and are as effective on small work as on large work. Suggestion, education and persuasion will obviate much of the need for coercive measures.

Especially should the foreman be in full sympathy. Not only is his the closest authority, but he is the natural teacher of the men and the example whom they emulate. The foreman often makes the best rule book and danger signal. If you can interest him, help him to see clearly the causes and remedies of accidents, if you can make him feel that accident prevention is worth while, I venture to say that three-quarters of the work is accomplished He is in the best position to note the real hazards of the work and determine the true causes of accidents. He is closest to the men and his influence to induce them to acquire safety habits can be enormous.

There is another feature of accident prevention, and a very important one, to which I should like to call your attention. This concerns itself with the selection of men for work and their instruction in it. Too little attention, from the safety standpoint, is often given to these matters. To put a heavy, slow-thinking man on a job requiring both bodily agility and mental alertness, or vice versa, is simply inviting accident. So, too, is assigning a man to work without carefully instructing him how to perform his duties safely as well as otherwise efficiently. Every new man on a job should be carefully instructed in general safety as well as in the safe way of doing his particular work.

## Sand and Gravel to Be Given Priorities in Accordance with Utilization

A war service committee representing the sand, stone and gravel industry has been appointed following a conference between men engaged in the industry with the War Industries Board. For purposes of war administration the country has been divided into 17 regions, Ohio and Michigan comprising one. As a result of the conference, it is stated, priority orders will be issued according to the following program: Producers of fluxing stone will have a clear way, as their product is essential to the manufacture of steel; ballast producers will also be given transportation facilities, in order to keep railroad beds in proper condition; limestone used for fertilizer will be given as adequate facilities as possible, while materials used in road building will receive consideration when materials for other purposes are not demanding immediate shipment. Exception will be made for urgent road work, but for general purposes road building material will be given consideration after stone and gravel for other purposes mentioned have been taken care of.

**French Mission to Visit American Industrial Plants.**—A mission composed of French ordnance engineers, technical experts and shop foremen is now in this country for the purpose of studying American methods of manufacture of war material. The mission will visit the principal arsenals and private plants engaged in the manufacture of war materials and will not only consider the engineering features but production and inspection as well, where the particular projects are far enough advanced to permit it. All communications relative to the activities of the mission should be addressed to Secretary, Franco-American Ordnance Committee, Army-Navy Bldgs., Group B, Room H 215, Washington, D. C.

## Repairing and Oiling Dump Cars

By adopting a systematic method of oiling and repairing dump cars by special men assigned to this work a mining company greatly decreased the upkeep cost of the cars. The plan is described in a recent issue of the Engineering and Mining Journal to which we are indebted for the matter in this article. The mine moved 500,000 tons of ore and waste a year, which was trammed by between 150 and 200 shovelers, hand trammers, mule drivers and storage battery handy men, requiring about 250 mine cars. Previous to the adoption of the new system repairs were made by sending a mechanic and his helper under ground from the machine shop to do the work. If the mechanics were not available the marker often made what repairs he could to keep the car in operation. The car oiling usually was done by the laborers. During the first 6 months of 1917 this manner of repairing and oiling cars was rather closely observed. It was estimated that not less than $3,000 per year was being wasted through time lost by the men in fixing their own cars and in looking for cars in good condition when something happened to the ones they were using.

The following costs were obtained during this period, January to June, 1917: Total cost of oils, $152.94; of car repairs, $1,191.33; cost per "ton 1,000 ft." of oils $0.00017; of car repairs $0.0012. The number of "ton 1,000 ft." per car was 4,260.

**Repair Men Assigned to Look After Cars.**—During the second half of 1917, a mechanic and one helper were put on the mine payroll, solely for the purpose of oiling and repairing cars. These men made daily inspection of the cars underground, attending to those needing it. Whenever a car was noticed in bad condition, the repair men were notified, and one or both would leave their regular runs to attend to it.

On the various levels, space was provided for making repairs of a more serious nature. When a car was badly damaged, it was left at these places and promptly looked after by the mechanics. If any forge work were necessary, the car was taken to the surface, where a separate shop was provided especially for this work.

Enough spare cars were kept on each level, in conveniently situated though unused places, so that if one were broken another was immediately available. Spare chains, car hooks, grease caps, for roller bearings, bolts, etc., were kept on hand. All parts subject to repeated damage, such as car hooks, were bolted instead of riveted on, permitting more rapid repair. At times when only minor repairs were necessary, the mechanic and his helper would inspect every four days and keep in good condition all of the 250 mine cars in use. Each car was inspected at least once every 10 days.

**Proper Lubrication of Roller Bearings.**—The question of car oiling was rather carefully investigated at this time. All mine cars are equipped with roller bearings, which reduce car resistance to about half of that required for plain bearings. The use of this type of bearing has permitted an increase in the size of cars used in mule haulage from 30 to 40-cu. ft. capacity, and the length of train from six to seven cars. To operate roller bearings to the best advantage, it is necessary to have the bearings full of lubricant at all times, the rollers floating in grease. If this is not done, the resistance is as great as if not greater than with well-oiled plain bearings. Several oils and greases ranging in price from 6 to 15 ct.

per pound were tried out in the bearings, with the following results:

With oils, there was a constant leakage around the wheel, and the oil would not remain in the bearings long enough to lose its lubricating qualities.

Greases of ordinary consistency were too thick and would ball up in the axles. There was not enough heat generated in the bearings to cause them to become soft and run into the roller bearings.

Mixtures of oil and grease in various proportions did not seem to have the desired lubricating qualities, and when made soft enough to be forced into the bearings with a grease gun, they tended to run out, as did the oil alone.

Samples of non-fluid oils or transmission grease of the consistency of soft vaseline were finally tried out, and were entirely successful. These greases are of moderate price, about 12 ct. per pound, and can be readily injected with a hand-operated grease gun. They will not run out of the bearings, although they flow freely to all parts. It has been found unnecessary to oil mine cars with these greases more than once a month, and in many cases once in six weeks is sufficient, and then only a small quantity is required (0.62 lb. per axle).

**Car Duty Under New System.**—The following costs were obtained during this period, July to December, 1917: Total cost of oils, $364.07; of car repairs, $2,666.22; cost per "ton 1,000 ft." of oils $0.00015; of car repairs, $0.001. The number of "ton 1,000 ft." per car was 9,952.

For a full year's operation these figures represent a saving in expense of $100 for oil, and $1,000 on car repairs, besides the estimated saving through having all the cars in use, and in good running condition all of the time, of not less than $3,000. This is a yearly total of $4,100, or a saving of $0.008 per ton on all ore and waste moved. These figures were obtained while this system of car repairing was being installed, and now that it is in full operation and working smoothly, it is estimated that $500 per year can be saved on oil, $1,500 on car repairs and $3,000 in time, making a total of $5,000 a year, or $0.01 per ton of ore and waste moved.

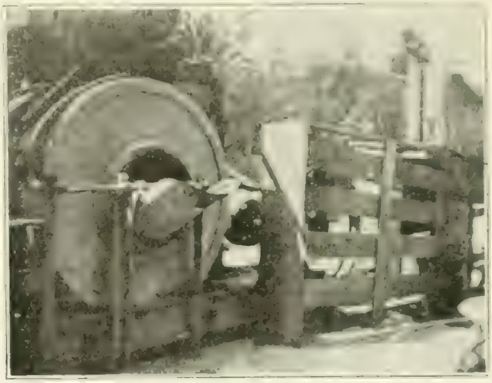
## Steps Taken to Form National Association of General Contractors

Steps have been taken for the formation of a national association of general contractors. Action toward this end was taken by a number of contractors who were in attendance at the Atlantic City convention of the building industries. An executive committee, composed of members of some of the largest contracting firms in the country, was appointed and a constitution drawn up. This tentative constitution provides that "members of the association shall be regional, sectional or local organizations of general contractors, or individual firms engaged in general contracting where there does not exist an association eligible to membership." It is further provided that all affairs and activities of the association shall be conducted by an executive board of 15 members and the three elective officers, president, vice-president and treasurer. The secretary would be a paid official and would maintain and conduct the general offices which it is proposed to locate at Washington during the remainder of the war. D. A. Garber of the Northeastern Construction Co., 225 Fifth Ave., New York City, is chairman of the committee.

## Safeguarding Construction Equipment

Unguarded machinery on construction work in California was responsible for 17 fatal injuries in the three years 1914-16, according to accidents reported to the State Industrial Accident Commission. In the same period there were 195 permanent and serious injuries due to this cause. Discussing these accidents in the California Safety News, Mr. J. J. Rosedale, Construction Engineer of the Commission, states that from the average amount paid for compensation and medical fees per accident, it is computed that the 17 fatal accidents for the three years cost $40,000, and the 195 permanent and serious injuries, $214,500.

Considerable difficulty has been found in inducing contractors to safeguard their machinery. There are several reasons for this; first, that most machinery used on construction work is rented by the contractor and is delivered and connected by the owner of the equipment; the contractor when informed by an inspector to safeguard such machinery usually refuses, for the reason that he does not own it. Second, both the owner of the equipment and the contractor argue that it does not pay to safeguard equipment because the job will last only a short time. Third, the speed and high pressure under which most construction work is performed causes the contractor to evade the law, and avoid anything that he thinks will retard the progress of the work. Fourth, the workmen themselves often discard safeguards from circular saws and other machines.



Home Made Guard on Gasoline Engine Driving Concrete Mixer.

Practically all of the machinery used on construction work can be guarded with home-made guards. There is nearly always enough surplus lumber and nails lying around construction work to safeguard fly-wheels, belts, pulleys, gears and sprocket-chains. The accompanying illustration shows how one contractor is safeguarding the gasoline engine running his concrete mixer.

**Spruce Tree Serves as Derrick Mast.**—A small spruce tree located at the edge of the clearing of the ship yard of the Feeney & Bremer Co., Tillemook, Ore., is used as a mast for a derrick handling ship timbers. A steel jacket has been placed on the tree to protect it at the point where the derrick boom swings.

## Creosoted Wood Water Tanks for Railway Service

Creosoted timber has been adopted recently by the Illinois Central Ry. for its standard wooden water tanks. Seven of these tanks constructed during the past winter proved so successful that the railroad is now building more and has practically made the creosoted tank standard, states Mr. C. R. Knowles, Superintendent of Water Service, in an article in The Railway Maintenance Engineer.

Although many different timbers are commonly used untreated in the construction of water tanks, there are but few that are available in suitable sizes and lengths to be used in the construction of large tanks, and when the life of the timber is considered this list may possibly be reduced to two timbers, namely, cypress and redwood. The great demand for these timbers has been such their price has advanced rapidly and suitable lengths are difficult to obtain. Undoubtedly the timber situation will grow worse as the war continues. Thus the use of lower grade timber that will take treatment readily appears to be a timely move.

The creosoted tanks being built by the Illinois Central are of their standard sizes, 100,000 gal. capacity with a 20 ft. stave and 30 ft. bottom, and 50,000 gal. capacity having a 16 ft. stave and 24 ft. bottom, no change having been made in the plans formerly used for the construction of untreated wood tanks. The timber used is loblolly pine coming under the general specifications for tank timber except that no restrictions are enforced as to heart or sap. The timber is air seasoned and should be permitted to season for three months in favorable weather.

The timber is treated by the Rueping process, using about 5 lb. of oil per cubic foot of timber. The oil used is American Railway Engineering Association No. 1 coal tar creosote. The tank tower, constructed of 12 in. by 12 in. posts and 6 in. by 8 in. braces, roof, frost box, ladder and all timber entering into the complete structure is creosoted.

A very important feature in the construction of these tanks is that all timber more than 1 in. in thickness is framed before treatment. The work of framing the tank before treatment is given such careful attention that it has rarely been necessary even to bore a hole in the treated timber during the field erection of the tank. The work of framing and treating is done by company forces at the Grenada, Mississippi, creosoting plant. The tanks are erected by line gangs. Thus in the manufacture and erection of these tanks the Illinois Central is independent of outside forces except the mills who cut the timber and ship it to Grenada in the rough.

When one discusses creosoted tanks for the storage of water the question is immediately raised as to the effect of the creosote on the water. In the tanks constructed on the Illinois Central the effect from the creosote in the water was so slight as to be hardly noticeable, and had no detrimental effect upon the water whatever. The Bureau of Industrial Research of the University of Washington conducted extensive tests of creosote wood stave pipe to determine its effect upon water for domestic and irrigation purposes.

The test was conducted to determine the effect upon water carried by a 56-in. creosoted wood stave pipe line 22½ miles long, from the Landsberg intake on the Cedar river to the Volunteer Park reservoir in the City of Seattle. In conducting the experiment a smaller pipe was used, but care was exercised to have the conditions in the experiment representative of those existing in the large pipe line. The conclusions of the Bureau were that there was no detrimental effect on the water from the creosote. These conclusions have been borne out fully by the results obtained on the Illinois Central with its new tanks.

## Malaria Prevention Work by St. Louis Southwestern Ry.

The St. Louis Southwestern Ry. within the last few months has created a new department that devotes its entire time to the elimination of malaria from among the 15,000 employes working over approximately 2,000 miles of trackage in five states. The anti-malaria campaign inaugurated by this railway was described by Mr. H. W. Van Hooverberg, formerly sanitary engineer of the company, in a paper presented at a conference of the National Malaria Committee, from which the matter following is abstracted.

The St. Louis Southwestern Ry. anti-malaria demonstration work for 1917 included the protection of the employes themselves from mosquitoes through screening, and the eradication of malaria bearing mosquitoes from cities and towns by removing and destroying their breeding places.

A large number of employes live and sleep on cars fitted up for the purpose. These work trains of various kinds are often located in highly malarious districts, thus exposing the men to infection. For the months of May to October, 1916, 13 per cent of all the malaria patients in the employes hospital came from the bridge and building department, which department employed 1 per cent approximately of the total employes of the road.

J. M. Herbert, president of the St. Louis Southwestern System, ordered all cabooses, extra gang cars, work trains and bridge and building cars screened before the mosquito season of 1917. He gave his personal attention to this work to the extent of inspecting the screening of outfit cars while on tours of inspection along the line. As a result of these measures it was found that the relative number of hospital cases from the bridge and building department alone decreased nearly one-half in 1917. The records show that for the months of May to October inclusive in 1916, one employe from the bridge and building department went to the hospital for malarial treatment for every 3,960 man-hours of labor put in by the department, while for the same period of 1917, one man went to the hospital for every 7,580 man-hours, a relative decrease of 47.7 per cent. Screening the sleeping quarters of these employes was undoubtedly responsible in a large measure for this great reduction. Orders are now out, directing that all screening be repaired and that new screening be done wherever needed, in preparation for the 1918 mosquito season.

Protection of the men living on work trains is secured easily and without undue expense. Screening of windows and doors must be well done, and only screen wire having 16 meshes or over to the inch should be used. Screen that will keep out flies will not be effective against mosquitoes. Defective screening will permit mosquitoes to enter the sleeping cars at night. At daybreak they try to get out, but in the short interval before full daylight they are unable to find the particular hole in the screen that they searched half the night for. Consequently the car becomes a mosquito trap and the infected mosquito must hide and await her time to bite another victim and thus spread malaria from one person to another in the same car.

Holes in the floors, walls and ceilings of the cars should be completely closed, and the screen door braced against sagging. Painting the ceilings of the cars white and puttying up all the cracks will permit swatting the mosquitoes each morning at daybreak.

The fumes of certain chemicals when burned will destroy the adult mosquito. This should be done at night before retiring, since the malaria bearing mosquito does her biting as a rule only at night, and she may not give notice of her presence about the car to the sleepers because she does not make the loud humming sound usually associated with the more numerous and better known varieties of mosquitoes. In handling construction trains the officials in charge of work crews should choose points for the location of cars that are as far removed from mosquito breeding areas as possible. Perhaps a very little work with shovels will drain standing water near outfit cars or a few applications of oil will destroy the breeding areas of myriads of mosquitoes.

Certain railway employes are not easily protected from malarial infection. For instance, conductors, engineers, firemen and brakemen may work several ways out of a division point. They may sleep in several different places during the week and they may be obliged to sleep without proper protection by screens. These men can protect themselves by use of mosquito bars carried with them for this purpose, or they may resort to the use of quinine. It is well known that quinine, when used in suitable amounts and at required times, will render most people immune from malarial infection. Such a method of protection against malaria has been practiced for years in many tropical countries. The St. Louis Southwestern Ry. proposes, during the oncoming malaria season, to supply quinine free of cost to employes on certain work who express a desire to help themselves to have good health.

## Compressed Air Terms

The following definition of certain compressed air terms have been adopted by the Compressed Air Society, with headquarters at 30 Church St., New York City:

The displacement of an air compressor is the volume displaced by the net area of the compressor piston.

The capacity should be expressed in cubic feet per minute and is the actual amount of air compressed and delivered, expressed in free air at intake temperature and at the pressure of dry air at the suction.

Volumetric efficiency is the ratio of the capacity to the displacement of the compressor, all as defined above.

Compression efficiency is the ratio of the work required to compress isothermally all the air delivered by an air compressor to the work actually done within the compressor cylinder, as shown by indicator cards, and may be expressed as the product of the volumetric efficiency (the incompression), all divided by the indicated mean effective pressure within the air cylinder or cylinders.

Mechanical efficiency is the ratio of the air indicated horsepower to the steam indicated horsepower in the case of a power-driven machine.

Overall efficiency is the product of the compression efficiency and the mechanical efficiency.

## Increased Attendance at Technical Schools Urged

The nation's need for technically trained men is defined and a specific higher education program urged in the report of Secretary Lane's special committee on higher education and industry. The report, which was made public last week, points out how essential it is, if the Government's far-reaching military plans are to be carried out successfully, that the processes of higher education be maintained at the highest possible efficiency—especially those having to do with the future supply of men and women trained in scientific and technical subjects, including teachers in these fields.

That it is impossible to exaggerate the importance of engineering knowledge and skill, in the broadest sense, is the judgment of Secretary Lane's committee, not only directly in the conduct of military operations, but indirectly in the essential war industries, including agriculture. The report says:

> The [illegible] United States are [illegible] greater than those of any other of the [illegible]. For an average distance of more than 4,500 miles, across the continents and the seas, we must transport all of the men, munitions, and supplies, which are to represent us in this great struggle. Furthermore, the central powers prepared themselves for this conflict over a long period of years, and by this means determined its character to their own advantage in large measure. The loss by our allies of men of highly specialized training in the early stages of the war, and the difficulties in the way of recovery, leave this Nation in the position of trustee of the only remaining sources of supply.

Pointing out how the War Department has already taken steps, through the establishment of the student army training corps, to utilize the higher educational institutions in training young men under 21, Secretary Lane's committee makes the following recommendations:

> The people of the United States should recognize that the maintenance of the war strength of the Nation in its full power demands the utmost efforts of all existing well organized and adequately equipped colleges, universities, and technical schools. This means ever increasing and more devoted bodies of students as well as faculties.
>
> Young people having the requisite qualifications should heed this urgent call of their country, and apply themselves diligently, enthusiastically, and in increasing numbers to the task of preparing for the highest service of which they are capable. Wherever practicable, young men should at the same time join the students' enlisted reserve and prepare for military service, in order to be ready for that call also when it comes.
>
> Institutions of higher education should adjust their courses, so far as possible, to immediate war needs and to the demands which must inevitably come with the establishment of peace, and [illegible] of study which are essential to the winning of the war, to the development of our industries and commerce, and to the accom-[illegible] Nation.
>
> Educational institutions should use every effort to make the opportunities and privileges of training for public service accessible to all suitably prepared men and women of college age. In [illegible]

The committee consisted of Fuller E. Callaway, a financier of LaGrange, Ga., Samuel M. Felton, director general of military railways for the War Department, and President E. A. Alderman of the University of Virginia.

## U. S. to Establish $30,000,000 Gun Relining Plant in France

Announcement is made by the Ordnance Department of the approval of the plans for the manufacture of the machine tool equipment which the United States will install in France for relining the heavy railway mount guns of from 8-in. to 16-in., up to 50 calibers in length.

The project for this relining plant is one of the largest undertakings by the Ordnance Department and will call for the expenditure before completion of from $25,000,000 to $30,000,000. The plant will be comparable in size with the Krupp Gun Works at Essen, Germany.

The machine tools alone required for this project will cost between $15,000,000 and $20,000,000 and embrace some 218 units, including gun boring lathes, engine lathes, rifling machines, and grinders.

Included among the facilities required for the manufacture of these tools was a planer of unprecedented length—500 ft.—to cost $450,000. The largest planer previously built was 186 ft. in length. The outstanding feature in the construction of these planers is the use of reinforced concrete for the bed plates. This results not only in a very material reduction in the time required to build the all important item—but also reduces the cost and saves iron for other war industries.

In addition to the machine tool requirements there will be needed extensive shrinkage pits for heating the gun jackets in order to remove the old liners and insert the new ones; a full equipment of 240-ton traveling cranes; a steam-electric generating plant of approximately 5,000-kw. capacity with its complement of boilers, pumps and other accessories; and the electric motors for driving the machines. There will also be required extensive housing facilities for the equipment and the personnel to operate it.

The Ordnance Department has completed the engineering work on this whole project in less than 30 days from its inception. In that time the project has been reviewed and approved by the Chief of Ordnance, passed by the Clearance Committee of the War Industries Board, negotiations concluded with machine tool builders, and procurement orders issued for the production of the tools required. Under ordinary conditions the engineering work on a project of this magnitude would have required over four months.

## The Dump Car in Industrial Operation

Many industrial concerns, according to the Earth Mover, are now employing dump cars for transportation purposes. The Carnegie Steel Co. of Youngstown, O., uses 30-yd. air dump cars for hauling cinders. The U. S. Steel Corporation in stripping operations on the Mesaba Iron Range hauls the overburden in 20-yd. cars of the most modern design obtainable. The same is true of the Copper Queen Consolidated Mining Co. at Bisbee and Douglas, Ariz., as to both overburden and low grade ore. Still larger cars are used by the Anti-Costa Island Co., which transports light wooden blocks for the manufacture of paper pulp by means of dump cars of 44-yd. capacity. The Illinois Central R. R. finds it profitable to haul rubbish from its yards in 30-yd. dump cars.

## Personals

F. L. Nicholson, chief engineer of the Norfolk Southern R. R., has been appointed consulting engineer for the Virginian Ry.

A. S. Baldwin, vice-president of the Illinois Central R. R., has been elected vice-president.

S. J. Williams, Jr., has resigned as principal assistant engineer of the Wheeling & Lake Erie Ry.

J. W. Fox, heretofore valuation engineer of the Central of Georgia Ry., has been appointed chief engineer.

E. R. Lewis, heretofore assistant to the general manager of the Duluth, South Shore & Atlantic Ry., has been appointed Chief Engineer.

M. J. Kennelly, formerly superintendent of the Cotton Belt and Rock Island, has been commissioned a major in the U. S. Railway Engineers.

A. J. Witchell has been appointed chief engineer of the Spokane & Inland Empire R. R. at the United Rys. Co., with headquarters at Portland, Ore.

J. A. Atwood has been appointed chief engineer of the Pittsburgh & Lake Erie, Lake Erie & Eastern, and Monongahela railroads, under Federal management.

Ralph Budd, formerly chief engineer of the Great Northern Ry., has been elected chairman of the corporate executive committee of the Chicago, Burlington & Quincy R. R.

H. D. Earl, former superintendent of the Cotton Belt Ry., with headquarters at Pine Bluff, Ark., has been appointed general superintendent of seven railway lines in Texas by A. G. Whittington, general manager of the lines under government control.

W. Nelson Smith, consulting electrical engineer, has been appointed to the staff of the Winnipeg Electric Railway Co., Winnipeg, Man., succeeding J. T. Donahoe, who resigned recently. He will make a study of matters affecting electrolysis, power requirements and electrical distribution.

A. A. Mathews, Chief Engineer St. Louis Southwestern Ry., has been appointed assistant chief engineer for all lines under jurisdiction of Federal Manager J. L. Lancaster. The other appointments for this Federal District include: E. S. Pennbaber, assistant to chief engineer; R. L. Holmes, engineer of water supply; W. D. Williams, bridge engineer.

Theodore Brent, former member of the shipping board and at present a traffic expert with the fuel administration, has been appointed traffic manager of the Mississippi River Barge Line. It is expected that a barge line freight service between St. Louis and New Orleans will be in operation on a weekly schedule on and after Sept. 1. The Government has acquired 40 steel barges and five towboats to inaugurate the service.

M. J. Caples, vice-president of the Hocking Valley Ry. and the Chesapeake & Ohio Ry., has been elected director and vice-president of the Seaboard Air Line Ry. Mr. Caples entered the service of the Boston & Maine Ry. in 1883 and filled positions from rodman to division engineer. He entered the service of the Norfolk & Western R. R. as resident engineer of construction in 1889 and afterward served as train supervisor, division engineer and superintendent. In 1905 he became general manager of the Carolina, Clinchfield & Ohio Ry. He had charge of the building of that road and directed operations as vice-president and general manager for 2 years. He became vice-president in charge of operations of the Chesapeake & Ohio and the Hocking Valley Ry. in November, 1911, and has been with the latter two companies for 7 years.

## Obituaries

Sir George Christie Gibbons, K. C., chairman of the Canadian section of the International Waterways Commission, died Aug. 8.

C. A. Goodnow, director of electrification of lines for the Chicago, Milwaukee & St. Paul R. R. and Vice President of the company, died last month at Seattle, Wash.

Henry W. Klausmann, City Civil Engineer of Indianapolis, Ind., died recently at his home in that city. He was born in Marion County, Indiana, Sept. 2, 1868, and moved with his parents to Indianapolis when he was 10 years old. He engaged in the engineering business in 1891. From 1901 to 1910 he served three terms as county surveyor. He was city civil engineer under the Shank administration. Mayor Charles W. Jewett appointed him city engineer Jan. 7, 1918. When not in public office Mr. Klausmann conducted a general contracting business, engaging principally in the construction of large office buildings.

Col. David C. Dodge, a pioneer railroad builder, died July 19 at Denver, Colo., aged 81. Colonel Dodge entered the raliroad business in February, 1853, beginning as chairman on an engineer corps of the Fox River Valley R. R. in Illinois and Wisconsin and in the engineer corps of the Wisconsin Central R. R. From March, 1856, to 1857, he was with the engineering department of the Chicago, Iowa & Nebraska road. He came to Denver in the early sixties. His chief accomplishment was the building of the Denver & Rio Grande R. R. from Grand Junction to Salt Lake City, Utah, a distance of more than 300 miles through the hardest kind of country. He also was instrumental in the construction of the Great Western Sugar Co. at Loveland, Colo.; the Western Packing Co. of Denver, the Denver Union Water Co. and the Shirley Hotel.

## Industrial Notes

J. H. Fenton, of the Los Angeles office of the Westinghouse Electric & Mfg. Co., has recently been appointed manager of the industrial division of that office, which includes jurisdiction over the Tucson and El Paso offices.

The Chicago Pneumatic Tool Co. announces that contract has been let and work started on the erection of an up-to-date addition to its Cleveland Plant, which is planned to double the present output. It is expected that work will be completed on the building itself about Nov. 1. The necessary equipment has been ordered and it is believed will be delivered and ready for installation by the time the building is completed, so that the additional production contemplated will be available very soon thereafter.

The Walter A. Zelnicker Supply Co. recently secured the services of Merle G. Peterson, who is now connected with the company's Chicago sales force at 428 First National Bank Bldg. Mr. Peterson was formerly associated with the Niles-Bement-Pond Co. and Pratt & Whitney Company. The Zelnicker Co. also has recently added to its sales force Henry Stroh. For the past 10 years Mr. Stroh was connected with the Elliot Frog & Switch Company, prior to which time he was associated with the Republic Iron & Steel Co., both of East St. Louis.

*Building and Structural*
*Monthly Issue*

ENGINEERING *AND* CONTRACTING

Halbert P. Gillette, *President and Editor* Lewis S. Louer, *Vice President and General Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year, but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering field. [illegible]

**Roads and Streets—1st Wednesday**
[illegible]

**Waterworks and Hydraulics—2nd Wednesday**
[illegible]

**Railways and Govt. Works—3rd Wednesday**
[illegible]

**Buildings and Structures—4th Wednesday**
[illegible]

Volume L CHICAGO, ILL., AUGUST 28, 1918 Number 9

## The Union of Local Societies with the American Association of Engineers

The American Association of Engineers publishes a monthly periodical called the Monad, and every issue contains many articles that should be inspiring to all engineers who have faith that the combined action of engineers will raise the entire engineering profession in public estimation. The Association has done a great work already, and under its new secretary, C. E. Drayer, will undoubtedly make itself felt more and more. Mr. Drayer brought about the plan of combined membership of the American Association of Engineers and the Cleveland Engineerinf Society. It is his belief that this plan will be adopted by many other local societies. Certainly the belief in co-operative union between local and national societies is rapidly approaching unanimity. Doubtless specialized local societies will eventually associate with the corresponding specialized national societies. But there are many local societies and clubs that include technical men of almost every class. These certainly should affiliate with one or more national societies of equally broad scope.

## The Thinking Habit Should Be Wedded to the Doing Habit

There are more than a thousand "trade, business, professional and other "class periodicals" in America, not to mention thousands of books that summarize much that has appeared in these periodicals. In spite of the vast volume of educational matter thus produced annually, our general increase in economic efficiency is disappointingly slow. Years after improved methods of doing things have been given wide publicity, the older and less effective methods remain in general use. And this is true even where the new methods are so simple as to be readily understood, and where they can be put into effect with little or no capital expenditure. Then why this prevalent inertia in a nation of people as intelligent as ours?

The answer here, as in similar problems, is to be found by a study of the principles of psychology; and in this case we must study the psychology of habit. Our schools, not excepting most of our colleges, are at fault in that they give little attention to the formation of the habit of following up a reasoned conclusion by a physical action. We are trained to understand rather than to apply our understanding. Boys, for example, learn the "principle of the lever" in their high school physics, and are taught how to solve certain problems by its aid. But they are not trained to apply the principle again and again in a great variety of practical ways. So, although they may form the habit of thinking mechanically, they are not grounded also in the habit of applying mechanical laws and principles.

We are now referring not merely to the general lack of manual training in our schools, for that is but one phase of a wider matter. Our point is that students should be trained invariably to take some sort of action that will give immediate application to the conclusions that they have reached as a result of their studies. America is full of inventors who get no further than to make a few sketches of their ideas, and who raise a cry of priority when someone else goes further and makes the real physical device that their sketches forecast. Every village has its clever and sound reasoners who are habituated only to reason and not to act upon their conclusions. It is often a puzzle why these thinkers "get nowhere," when it is evident that all progress is due to thinking. But the puzzle is solved the moment it is realized that most thinkers are not doers.

## Why Airplanes Require So Much Spruce

Many engineers have doubtless been puzzled over statements that the airplane output was limited by the output of spruce. The average airplane contains less than 170 ft. board measure of spruce. An ultimate monthly output of 10,000 airplanes would therefore involve only 1,700,000 ft. B. M.—a really small quantity of lumber. Then why was there a shortage of airplane stock? Until very recently it required 70 ft. of timber in the tree to furnish 1 ft. in an airplane. About 15 per cent of the timber in the tree was clear enough and sufficiently straight grained to be suitable for airplane stock, and less than 10 per cent of the stock was used in the finished plane. However, about 20 per cent of the stock is now used, and the engineers hope to increase this to 30 per cent.

The Sitka spruce of northern California, Oregon and Washington supplies 95 per cent of the lumber used by our government and its allies for flying machines. This spruce is lighter and more resilient than any other timber available in large quantities, being fully 10 per cent superior to Douglas fir.

Less than a year ago the Spruce Production Division of the U. S. Signal Corps began organizing the spruce lumbering industry. There were only 3,000 men in the spruce camps of Oregon and Washington last November, where now there are 10,000. Some $3,500,000 worth of logging engines, wire rope and steel rails were secured for use in these logging camps, and a hundred mills are engaged in sawing the lumber.

Recently the head of the German aviation forces told German reporters that America's talk about producing 50,000 airplanes before the end of the year was only another sample of American bluff. It is well that he thinks so. Our output of these machines is fast reaching a rate that will be quite as amazing to the Germans as our shipbuilding output has become. Liberty motors, spruce and other airplane essentials have already reached "quantity production" rates, and will be delivered according to a schedule that provides ultimately for 100,000 flying machines annually.

## Should Gold Mining Be Subsidized?

At a recent meeting of gold mine owners and operators the government was importuned to subsidize the gold mining industry. Rise in wages and prices of materials has already caused many gold mines to suspend operation. Gold miners argue that since credit is based on gold, our expanding credit should be provided for by additional gold production. Mining periodicals have, in most instances, endorsed this contention. Is the argument sound? Certainly it is not, if there is any truth in that political economy law which states that the general level of prices varies with the quantity of money in use and its rapidity of circulation. If this is true—and no one has ever denied it—to encourage further production of gold by government subsidies to gold producers will have the disastrous effect of raising the general level of prices still more. Then the gold miners would demand a still greater subsidy, and so on endlessly.

The fact is that never in the history of the world has any nation had so great a per capita fund of gold as America now has. Coupled with this we have only recently adopted a new banking law that makes the gold more efficient as a basis for credit, as well as providing greater safety by virtually pooling the resources of the banks. If the authorities on political economy are right, America should rid herself of a large part of her gold, for her stock is already so great as to have produced excessively high prices.

The Mining Press recently said:

> There is but one way to protect both gold and general industry; and that is to build up the gold reserve faster and faster as a foundation adequate to sustain the growing national indebtedness. That indebtedness means services loaned, but the repayment must be made in currency, the only guarantor of which is the royal metal. The way to reenthrone gold as the arbiter of commercial value is either by crystallizing the prices for all commodities, or by letting all markets regulate themselves on the ancient principle of supply and demand. Half-slave and half-free it is certain that industry, commerce, banking, and insurance, will presently fall into a slough of difficulties from which we may not extricate them before appalling damage will have been inflicted not alone upon the economic life of our own day but upon that of generations to come.

There are two errors in this argument: First, it is not a fact that "repayments must be made in currency." Very little currency is used in the commercial transactions of this country, payments being made with checks and drafts. Second, the control of certain prices by the government has not caused increased costs of gold mining, but the exact reverse, so that it can not be maintained that the government should further relieve the gold mine operator by guaranteeing his profits. His profits would have been less had the government not kept many prices down.

The unexampled fall in the value of gold relative to other products has again raised the question whether nations would not be wise to abandon it entirely as the basis of domestic currency, using it merely to settle international trade balances. Certainly it would seem that the time has come when enlightened nations can safely undertake to use nothing but "credit money" for domestic purposes, guarding against expansions of credit that will cause such unreasonable rises in general price levels as we have witnessed in the last three years.

## The Future of the Shipbuilding Industry in America

At the present moment no branch of the construction field is attracting as much attention or growing as rapidly as shipbuilding. This activity is likely to lead many structural engineers and contractors to believe that ship designing and building will be a good field to enter as a permanent occupation. Before coming to such a conclusion it will be well to study shipping statistics.

Prior to the war the merchant fleet of the world totaled 45,000,000 tons, of which Great Britain had 18,000,000 tons. The net loss (gross loss minus new construction) in the tonnage since the war began has been only 5,200,000 tons. During 1918 America will turn out 4,000,000 tons and the rest of the world about an equal amount. Submarine destruction during recent months indicates a total sinking of about 4,000,000 tons for 1918.

Schwab has predicted an output from American yards of 10,000,000 tons in 1919; and Hurley states that if the 750 ways used for cargo ships average three vessels each in 1919 the output will be 13,500,000 tons. It is America's plan to build fully 25,000,000 tons, which alone will increase the world's tonnage to 75,000,000 by the end of 1920, a gain of 50 per cent over the tonnage existing prior to the war. The greatest shipbuilding nation in the world, Great Britain, never turned out as large a tonnage in any five years as America will turn out in one year if the 13,500,000 tons output is reached.

It is perfectly evident that no matter how rapid the growth of water borne commerce may be after the war, the shipbuilding facilities will far exceed all need for increased tonnage. In this connection it is worthy of note that the efficency of ships as cargo carriers has increased greatly since the war began, and will increase much more. This has been effected by speedier loading and unloading of vessels. Statistics have been given out by Hurley indicating increases of 50 to 100 per cent in the number of round trips per annum made by vessels to South American and European ports.

The present number of ship ways in America is 660, and 160 more are under construction; 750 of these will be under the direction of the Emergency Fleet Corporation. The speed of constructing and equipping ships has increased at an amazing rate, so that estimates of the output of the yards have been greatly exceeded. When 5,000-ton ships began to be launched in 60 days, astonishment was expressed by all acquainted with shipbuilding. Then a 12,000-ton vessel the "Defiance," was launched in 38 days. Following immediately from the same yard a sister ship, the "Invincible," was launched in 24 working days, or 30 calendar days. Fifteen hundred men working day and night accomplished this feat. Consider what this means. At this rate 12 ships of 12,000 tons each would be built annually on each way, or four times as many ships as Hurley estimated per way per annum!

During July 123 American vessels were launched, totaling 632,000 tons, which is a greater output in one month for this country than in any single year in the past. The tonnage launched by months has been as follows:

| | |
|---|---|
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| Total | [illegible] |

When it is remembered that the largest shipyard in the world (Hog Island with 50 ways) did not launch its first ship till Aug. 5, and the first launching at the Bristol yard (12 ways) did not occur till Aug. 3, the July record makes it clear that before the end of 1918 we shall have reached an output of fully 800,000 tons monthly. There are now 300,000 men engaged in our shipyards and 200,000 more in fabricating steel, building equipment, etc., for the ships. Hurley has said that this number will be doubled by 1920. But one may well ask why. Have we not almost reached the stage where we may well consider calling a halt on further increase in shipbuilding capacity? If the American output of ships is raised to 10,000,000 tons yearly and that of the other nations is 4,000,000 tons, the net gain over submarine and mine losses will be fully 10,000,000 tons yearly. This is more than twice what is required to provide the increased tonnage needed by our growing army and for other purposes. Why, then, should we continue piling Pike's Peak on Mount Tacoma?

In any event, it is evident that, after the war, ships and shipbuilding plants will be a drug on the market, for America alone will have a shipbuilding capacity three-fold as great as that of the entire world prior to the war.

## Why a Sewer Contractor Has Succeeded as a Ship Builder

Fully two-thirds of all large American contractors do not specialize exclusively, but engage in a variety of construction work. In times like the present there is a great shifting in the contract world from one class of work to another. An interesting and striking example is the Meacham & Babcock Shipbuilding Corporation, whose yards are on Lake Union, Seattle. In a recent interview Mr. Meacham said:

> [illegible]

> [illegible]

This company had six wooden ships of 3,500 tons each in the ways when they received telegraphic orders for two more at $550,000 each. Mr. Meacham, commenting on this, said:

> [illegible]

The noteworthy part of this interview is the point of view of a man accustomed to do outdoor construction work on a large scale. He regards himself as an executive capable of handling any such work, provided he can hire experts to manage it under his general direction. Accustomed to the problems of rapidly building up an efficient organization, a general contractor is capable of securing really astonishing results in a short time. This was demonstrated on a spectacular scale by the engineering contractors who built the cantonments so rapidly last year. It has also been demonstrated in fully as spectacular a fashion by such contracting firms as Meacham & Babcock in the building of ships. Contractors who had never before built a ship knew they could do it, for had they not built their first dam, or their first church without previous personal experience as builders of churches or dams? Theirs is the courage developed by success in venturing into relatively new construction fields, and courage is half of every battle. But note well the fact that such successful men do not rely on blind courage. They "engage experts in that line," and they themselves put the "pep" into the whole enterprise.

## Light Weight Concrete for Ship Construction

Numerous studies have been made recently for the purpose of finding a light weight concrete for ship construction. The Department of Concrete Ship Construction of the Emergency Fleet Corporation, according to the Emergency Fleet News, has succeeded in developing an aggregate weighing only 70 per cent as much as the aggregate commonly employed in concrete construction, which is satisfactory from the standpoint of strength requirements.

Tests of a volcanic scoria from New Mexico, made a few weeks ago at the University of Texas, indicated that this material would give a concrete weighing about 120 lb. per cubic foot and having a compressive strength of above 4,000 lb. per square inch at the age of 28 days. The volcanic scoria in a solid condition weighed 93.4 lb. per cubic foot. Crushed between $\frac{3}{4}$ in. and $\frac{1}{8}$ in. in size it weighed 39 lb. per cubic foot loose; the screenings passing the $\frac{1}{4}$-in. screen weighed 78 lb. per cubic foot loose. Good results also were obtained from tests of a sandstone which weighed solid 137 lb. per cubic foot.

Concrete made with the volcanic scoria, as coarse aggregate, and its screenings as fine aggregate, weighed 15 per cent less and had $12\frac{1}{2}$ per cent more strength than a limestone concrete made at the same time and in the same way. The concrete made of crushed sandstone and its screenings weighed 10 per cent less and was 12.4 per cent stronger than a similar concrete made with gravel and sand.

## Centrifugal Force and Reaction

To the Editor: The editorial comment as to centrifugal force and reaction in your issue of June 26, on my paper in the April number of Proceedings of the Society for Promotion of Engineering Education, comes to hand after my absence from home. Possibly the question may have enough interest for some of your readers to justify a brief rejoinder.

One point of your criticism is clearly stated in the final sentence as follows: "We have no objection to the use of the term centrifugal reaction, but we do strenuously object to the assertion that a reaction is not a force." Another point is clearly put when you say: "We do not say that inertia may not be a force (for it is doubtless better called an energy), but we insist that inertia cannot be excluded from the class of phenomena called force merely by including it among the 'properties of matter.'"

Noting the latter criticism first: does the term "property of matter" really exclude the idea of force? All conceptions of force are derived from its observed action on matter. Is it inconsistent to say that inertia is a property of matter which reveals the action of force—the force being external to the mass?

Reverting to the first quotation above we seem to be at once in partial agreement. And we may also consider that the literal meaning of "centrifugal" contradicts the fact, as an adjective of force. The definition of centrifugal in Webster's Dictionary is: "Proceeding or flying away from the center." But in fact the body, being constrained to move, say, on the arc of a circle, is being drawn constantly towards the center—pulled out of the straight line in which at every instant it tends to move, according to Newton's first law of motion. The writer of the definition amplifies by adding: ". . . it is this constant tendency to move in a straight line; in other words, the inertia of the body, which in its aspect of opposition to the centripetal force, is called centrifugal force." Thus this author clearly states the fact and then gives the popular or common term for the effect. The term centrifugal reaction exactly describes that effect as your editorial comment admits in the quotation given. One who clearly understands this would not say that a flywheel "bursts" in the same sense that a steam boiler bursts or a loaded shell explodes. He knows that the disaster happens when the cohesive forces in the material of the rim and in one or more spokes are overcome by the centrifugal reaction, and that the pieces then fly away tangentially, as when a stone is hurled from a sling.

But your more strenuous objection perhaps refers more especially to statical conditions. In lifting a heavy body from the ground muscular action is an impressed force equal and opposite to the weight (force of gravitation). Or, again, when two men pull equally each other at opposite ends of a rope (as in the "tug of war") there are two impressed forces directly opposed. Now suppose the rope to be cut and tied to a hook firmly fixed in a wall, while one man pulls as before. The tension in the rope is the same (although novices sometimes say that the rope pulled by two opponents has a tension equal to the sum of the two pulls); but the pull of the one man is now resisted by the hook. There is no force in the hook; but it offers an equal and opposite reaction. If the man pulls more or less the reaction varies accordingly. If the pull ceases so does the reaction—which is thus coexistent with the pull but neither pre-existent nor persistent.

In computations of the internal stresses in a bridge truss or plate girder we begin by computing the "reaction of the abutment," which is the proper designation of this external resistance to the weight there imposed. Of course the reaction is equal to the weight, and it is convenient to view it as a force when we write the equation in the form W = Reaction. But when lifting a load the opposition or stress is between weight and direct muscular effort, not reaction; or, W = direct pull. This may appear to be a trivial distinction, but it is there and it is well to observe it. Newton after years of patient observation and study, ennunciated his third law of motion thus: An action is always opposed by an equal reaction; or, the mutual actions of two bodies are always equal and act in opposite directions. There are two clauses in this statement. As the writer understands it, Newton intended by them to make the distinction just suggested. If not the second clause is little more than a needless repetition. It is as if he said, by the first one, the effect equals or is the measure of the cause, but is not the cause; and, by the other, the mutual actions of two impressed forces, causing stress between two bodies must be equal and opposite.

An author of cherished memory in an otherwise admirable text book, gives an example of robbing this law of its full meaning. He says: "A force is an action between two bodies. . . . There can be no force unless there are at least two bodies . . . there are two bodies and one action of force." Further on he states: "When a body like a block of stone rests upon the ground there are two actions between the stone and the earth, viz.: a pull and a push which exactly balance . . . ." Then, after quoting the third law he states: "This law of Newton does not explain the stability of the block of stone resting upon the ground in the former illustration. In that case there were two actions between the earth and the stone, a pull and a push, and the pull and push balanced . . . ." Here the beginner is told truly that there is one action or stress between two bodies; then that another action comes in as the push up of the earth; and finally, to add to his confusion, that Newton's law does not apply. More than a page of such futile explanation would have been saved by stating directly: The primal action or impressed force is the weight of the stone; the reaction or counteraction of the earth is equal and opposite to that, according to the statement of Newton's third law.

Reverting now to the kinetic aspect of the case, anybody, in a short time and with little labor, may make the following simple experiment: Fill a suitable bag with 50 lb. to 100 lb. of sand, and a similar bag of the same size with sawdust, hay or other light material. Suspend these by suitable cords from hooks firmly fixed 10 to 12 ft. overhead. Evidently these masses are perfectly free to move, as friction and air resistance are negligible. Now strike each in succession a very quick strong blow horizontally directed; or give a sudden pull by an attached cord of medium strength. The lighter mass will be sent flying on a wide swing, giving a moderate reaction against the fist. The heavier mass may offer enough resistance to injure the hand or cause the pulling cord to break; and its range of movement will be much less. Evidently the different behavior of the two masses, which may be made to look alike externally, is due to the fact that the quantity of matter in one is greater, although the size is the same, and the two blows equally quick and strong. There is no inherent force in them, as they are passive until struck. This experiment is suggested as affording tangible experience of reaction opposing muscular effort. [It may be used also to illustrate and verify other principles of mechanics.]

Admittedly we are discussing vexed questions. Some authorities urge, as you suggest parenthetically, that the relations of force, mass, momentum, etc., should be treated from the viewpoint of energy, or work, since the unit measure of force involves unit of acceleration; hence it is really an elementary quantity of work [$F = Ma$, and $M = 1$, $a = 1$]. Newton's definitions have been criticised and discussed by many later authorities and his "laws" restated accordingly. As they were written originally in Latin the variety in the renderings is not surprising. He, himself, suggested the term "force of inertia," but, as Barton says*: "There is a strong body of opinion that Newton's definition of mass is incomplete and illogical."

The foregoing considerations are submitted in the spirit of one conscious that, even after 40 years of teaching, he does not yet know it all. He believes, however, that they afford a satisfactory viewpoint of some of the fundamentals.

Robert Fletcher,
(Professor emeritus.)
Thayer School Civil Engineering,
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## How the Engineering Profession Can Help Its Younger Members

To the Editor: The letter from O. W. Childs of Washington, D. C., in your issue of Aug. 21 should be read by all engineers. The policy of the Government in regard to the employment of non-organized groups of employes contrasted with that followed in the employment of organized groups suggests the remedy for the former. From the engineer's standpoint it is to be regretted that the draftsmen in Washington have found it necessary to form a labor union in order to secure justice. This fact confronts the engineering profession as an unpleasant demonstration of its indifference to its younger members. If engineers, after having spent their time and money in gaining a technical education and joining the ranks of a profession whose main object is public service, cannot receive even as much consideration as union tradesmen, nor greater compensation, something should be done about it. The men in Washington did something, and if what they did was not the best that could have been done, it was, for them, better than nothing at all.

There are other places in the United States where similar conditions obtain, and if the existing engineering organizations cannot espouse the cause of the younger engineers when they are beset by trouble, the support that might be theirs from these potential leaders of the future will be lost. The American Association of Engineers has, as Mr. Child's letter states, been active and solicitous, not only in maintaining the professional character of engineering practice as distinguished from that of the usual trade union, but also in helping younger engineers by direct employment, by the education of the public to an appreciation of the real meaning of engineering, and by encouraging its members to think of themselves as individuals belonging to an army fighting for its ideals as well as for something more than a bare existence.

The national societies from their point of vantage in New York have, within the last year, been showing signs of uneasiness and dissatisfaction with their time-honored past. The Engineering Council has been formed. But evidence is accumulating which would indicate that the speeding-up processes of the war have been accompanied by no parallel acceleration in engineering organization.

One remedy which might be suggested for the situation in Washington which in other forms exists elsewhere, is the formation of an inclusive national organization of engineers for the purpose of promoting a sagacious and discerning business policy while maintaining the traditional technical activity of the past. There must be provided in this a mechanism, endowed with sympathetic insight, for reaching out to the far corners of the country and down to the veriest beginner in the profession. An organization with an intelligently controlled sensitive nervous system with quick apprehension and sane reactions, founded upon democratic principles will master the situation.

Frederick Bass,
M. Am. Soc. C. E.,
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Minneapolis, Minn.

## Second Largest Shipyard in U. S. to Be Built on Pacific Coast

With the Victory plant at Squantum completed and boats being launched there every few days, the Bethlehem Shipbuilding Corporation, has again turned its attention to further expansion and authorized the construction of a new shipyard located at Alameda, Cal., near the present plant of the Union Iron Works.

Contract for the construction of the plant was awarded to the Aberthaw Construction Co. of Boston, which recently completed the Victory plant in record time and who has handled practically all the wartime expansion of the Bethlehem Corporation, totalling more than $20,000,000 exclusive of the present work.

The Alameda plant will be the second largest in the United States exceeded in size only by Hog Island. It will be twice the size of the Victory plant at Squantum and will involve twice the expenditure. The plant, which will be complete for building on 10 slips, will cover over $\frac{1}{3}$ square mile and from 3,000,000 to 4,000,000 cu. yd. of dredging will be necessary. Large cargo vessels will be constructed, contracts for which have already been awarded to the Bethlehem Shipbuilding Corporation by the United States Shipping Board.

The formal opening of the work occurred on Aug. 13 when the first pile was driven. Five hundred men are already on the grounds and it is anticipated that the construction work will require the services of approximately 15,000 men within the next few weeks.

**116 Per Cent of Capacity of Bridge and Structural Shops Contracted For.** The records of the Bridge Builders and Structural Society, as collected by its Secretary, show that during the month of July, 1918, $116\frac{1}{2}$ per cent of the entire capacity of the bridge and structural shops of the country was contracted for. The total tonnage contracted for during the first six months of 1918 was 56 per cent of capacity.

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*Analytical Mechanics, Edwin H. Barton [illegible] Longmans, Green & Co. 1911, p. 185.

# Cost Plus Contracts

By P. B. GLASCO,

President George W. Stiles Construction Co.

The Convention of Building Industries which met recently at Atlantic City attempted to pass a resolution in favor of "Voiding so far as practicable so-called Cost Plus Contracts," inasmuch as various departments of the Federal Government looked with disfavor upon cost plus contracts. It seems strange that a body of men who should be well informed in regard to building matters under present conditions would attempt to pass such a resolution, and the fact that after discussion it was not passed, goes to show that there are a great many things to be said in favor of cost plus work.

The greatest advantage of the cost plus system is that on urgent work it permits work to be started without waiting for the plans to be completed, thus making a great saving in time, and also probably in cost, as an efficient contractor, working with an architect or engineer, can no doubt make suggestions that will save money as well as time.

If the work is not so urgent and will permit the finishing of the plans and taking bids, the proper kind of cost plus contract should save an owner money under present conditions, for in bidding on lump sum contracts, reliable and experienced contractors will undoubtedly add a larger percentage of profit than they would under ordinary conditions, and in addition put on considerable for contingencies in the way of advances in wages, prices of materials, freight rates, and other risks. If these contingencies do not arise, the owner still has to pay for them and the contractor makes a larger profit than he is really entitled to. In actual practice it has often worked out that all bids are considered to be excessive and the project is either abandoned or shelved for the time being, or else new bids are taken in the hopes of finding a contractor who is willing to take large risks for a slight prospective profit.

There has been abuses in connection with cost plus work, possibly more on public work than on private, but instead of condemning the cost plus system outright, it seems to us that it would be better to attempt to develop a cost plus system which would eliminate abuses as far as possible, and we believe that the best way of eliminating abuses is to give the contractor every possible incentive to make good. This can be accomplished by a system which puts the contractor on his mettle to achieve and maintain a reputation as an economical and efficient builder, and which also makes his pecuniary reward dependent upon his degree of success in carrying out his contract.

Where speed is essential and where it is desirable to start the work before plans are finished, the architect or engineer will naturally pick from the contractors known to him the one best suited for the particular job, and abuses can only be avoided, by securing a contractor of unquestioned honesty and ability. Where there is time, however, to prepare complete plans and specifications, some of the good points of lump sum competitive bidding can be combined with a cost plus system, which embodies the incentives of "making good" referred to before, and the owner can secure the benefit of both systems. An outline of such a combination which we have suggested to several architects and engineers recently and which has been used by them in taking bids, is as follows:

The architects or engineers invite four or five honest and competent contractors to submit competitive bids on the amount of the lump sum fee for which they will do the work on a cost plus basis. Each contractor submits with his bid on the fee a detailed estimate of the actual cost of the work and is required to guarantee his estimate to the amount of one-half of his fee; that is, if the actual cost should exceed the estimated cost, the overrun is to be deducted from the contractor's fee up to one-half the amount of the fee. This gives the contractor every incentive to keep the cost as low as possible in order that he shall earn his full fee, but is not so strong as to cause him to risk his reputation by slighting the work, as he is certain of at least one-half his fee. An added incentive for economy and efficiency is to give the contractor a percentage (usually 50 per cent) of any savings in cost under the estimated cost.

Several tryouts of this system, where the contractors were given their option of submitting either lump sum bids or cost plus bids, showed that the contractors were strongly in favor of the cost plus system, and in one case, at least, no bids were received on the lump sum basis, all the contractors electing to submit bids on the cost plus basis. In instances where lump sum bids were submitted the cost plus bids were found to be considerably lower.

An outline for invitation for either lump sum or cost plus bids which, of course, will have to be amplified or varied to suit any particular job, is as follows:

The owner will consider bids submitted on the usual lump sum basis, also bids on a "cost plus" basis. Contractors may bid under either or both methods as outlined below:

1. Lump sum bid to be made for all branches of the work as listed below, except that the mechanical branches may be omitted if desired. Bid shall state specifically all branches included:

Wrecking ........................................
Excavating
Masonry
Etc.
.....
..........

2. Cost plus bid shall state a lump sum fee for which the contractor will do the work on a cost basis, cost to consist of all expense in connection with the work except overhead expense of contractor's main office. The contractor shall also submit with bid his estimated cost of the work except the mechanical branches, but the superintendence and handling of these branches shall be covered by his lump sum fee. Any overrun of the cost above contractor's estimate shall be borne by the contractor up to one-half the amount of his fee, any balance by the owner. Any saving shall be divided equally.

Estimated cost shall be given in detail by branches as outlined below. For various items included under each branch refer to the general specifications.

Overhead expense shall include liability insurance, fire insurance, permits, temporary offices, sheds, fences, toilets, etc.; phone, heat, light, etc.; traveling expenses, superintendent, foremen, timekeeper, water boy, watchman, etc.; plant costs, freight, rentals, repairs, depreciation, tools, etc.; and other items of overhead expense.

The architect will require the contractors whose propositions are favorably considered to submit complete detailed estimates showing quantities, unit prices for materials and labor, sub-bids, together with original quotations, wage scales, etc., used in estimating, all to be checked and approved by the architect before contract is awarded.

[illegible]

[illegible]

Any architect or engineer can, no doubt, work out his own form of contract for this system of cost plus work, making it as simple or elaborate as he pleases, or if he wishes to get some ideas of the leading contractors' forms for cost plus contracts, he could do no better than refer to Engineering and Contracting, issue of Dec. 26, 1917, which contains several different forms.

Last but not least, on the cost plus work which we have done, we have found that our relations with the owner and architect have been most pleasant and agreeable as all our interests are identical, that is, to do good work as economically as possible; and as we are sure of a certain, if small, compensation for our skill and ability as builders, we find that much of the friction is eliminated which is bound to arise under a lump sum contract, where it is to the contractors' interest to do as little as possible under the plans and specifications, whereas it is to the owners' and architects' to demand as much as possible.

## Commission to Study New Mississippi River Crossing at New Orleans

The City of New Orleans has recently authorized the appointment of a Board of Advisory Engineers of the Public Belt Railroad Commission for the purpose of investigating the physical and financial feasibility of a new bridge or tunnel crossing of the Mississippi River at or in the vicinity of New Orleans, and the possibilities of united terminal development, both passenger and freight, through the agency of the Public Belt Railroad.

The Board consists of four members: Lt. Col. Bion J. Arnold, Transportation Engineer, of Chicago, Chairman; Dr. J. A. L. Waddell, Bridge Engineer, of Kansas City; Mr. J. Vipond Davies, Tunnel Engineer, of New York; and Mr. A. F. Barclay, Engineer of the Public Belt Railroad Commission, Secretary. The Board is working under the general direction of the Bridge and Tunnels Committee of the Commission, Mr. William B. Bloomfield, Chairman.

The possibilities of bridge and tunnel construction will be investigated by Dr. Waddell and Mr. Davies respectively, and the problem of terminal development and general co-ordination of facilities will be studied by Col. Arnold. The Board as a whole is instructed to submit a report by Jan. 1, 1919.

The field work has already commenced and is in charge of Mr. J. R. Bibbins, of Chicago, Mr. Charles K. Allen, of Kansas City, and Mr. A. R. Archer, of New York, resident engineers and representatives of the respective consulting engineers in the Board. The problem presented is complex not only by reason of the physical dimensions of the crossing project and foundation difficulties encountered in the Mississippi bottoms around New Orleans, but also due to the disposition of present railroad operations, traffic and rates in the Mississippi Valley and the possible effect in the future of railroad reorganization brought about by war conditions. The project as a whole is designed for permanent improvement, having in mind the development of the New Orleans District as far ahead as 1950.

# The Advantages of Flat-Slab Construction for Bridges*

By A. B. COHEN,

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**Principal Advantages.**—It is the object of this paper to show that the flat slab can be utilized with effectiveness and advantage in carrying heavy railway loadings in the construction of viaducts and especially bridges of lesser magnitude where the required span length is not prohibitive. All forms of concrete construction have this limitation.

The principal advantages of the flat slab compared with all other forms of reinforced concrete and other fireproof construction are embodied in the simplicity of both the formwork and arrangement of the reinforcing steel. The first cost of construction has been so reduced thereby as to put structural steel, in competition with the flat slab within its limitations, substantially out of consideration; furthermore, with the concrete construction lower maintenance charges prevail and greater permanency is obtained. The simple arrangement of the reinforcing steel, laid over a practically unbroken flat surface, insures a more positive placement of the reinforcing bars than the general beam and slab design in concrete.

In addition to these general advantages of the flat-slab construction, the salient advantages resulting from its adaptation to railway structures will be brought out in subsequent description and illustrations of actual examples. There is, however, one outstanding feature of the flat-slab system which in the writer's opinion is of most vital importance in reinforced-concrete construction. By reason of its uniform cross-section and continuity of the reinforcement, there is no other type of reinforced concrete that is better proportioned to resist shrinkage and thermal changes. Structures of the flat slab have been built in surprisingly great lengths without the incorporation of a single expansion joint and have successfully resisted the very severe strains of these stresses. By the insertion of an additional amount of reinforcing steel across construction joints, a constant tensile resistance can be maintained which has the effect of preventing cumulative action of the stresses at any particular section; the strain is distributed uniformly throughout, resulting in an infinite number of minute cracks that do not impair the strength of the structure.

Our experience does not extend over a sufficient length of time to ascertain definitely what effect the repeated action due to temperature changes will eventually have on the strength of the structures. However, very close observation of existing flat-slab structures, in service from 3 to 6 years, have disclosed no deleterious effect due to these causes. The minute cracks found were of no greater concern than those developing on the tension side of a beam long before the steel has reached full working stress.

By way of comparison in this regard, to show the difficulties encountered in other types of concrete construction, consider the special arrangements in the manner of expansion and sliding joints that are necessary and not always efficacious in large concrete-arch viaducts or in viaducts of the column, beam and slab design. In the viaducts consisting of a series of large main arches surmounted by transverse spandrel walls supporting a floor system, the vertical movement of the heavy arch ring, for a rise and fall of temperature, is transferred to the floor system. This very appreciable vertical movement must be resisted by the comparatively light floor in addition to its own changes in a horizontal plane. In the case of the beam and slab design the constituent members have different sections and therefore offer varying degrees of tensile resistance. There arises the difficulty of transferring the movement from the larger through the smaller members, as from the deep beams through the thin slab, which is not always satisfactorily controlled.

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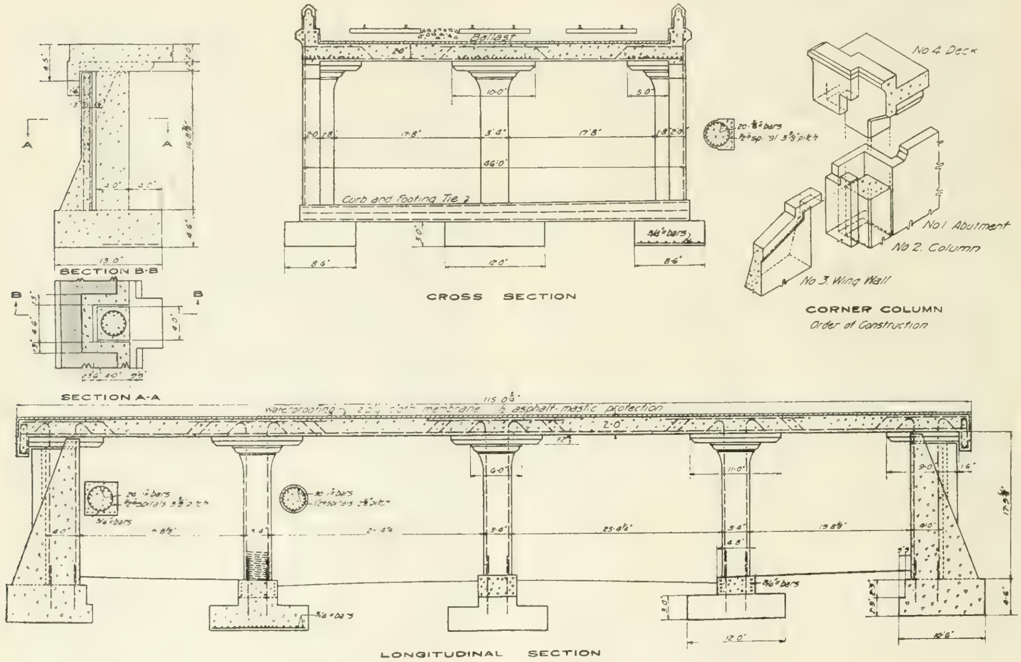


Fig. 1—Details of Flat Slab Bridge Constructed at Central Ave., Orange, N. J., by the Delaware, Lackawanna & Western R. R.

There are many advantages in addition to that of economy to be gained by this type of construction. It permits of more effective architectural treatment; because of the shallow floor depth the track can be laid in ballast which is a very important consideration in track construction; there are no girders projecting above the deck to encroach upon the lateral clearance or to interfere, as in this case, with the construction of the platform; the rigidity of the structure is noteworthy since no noticeable vibration is developed with the simultaneous passing of heavy locomotives at high speed on all three tracks; by reason of the rigidity and of the ballasted floor, the rumbling noises common to structural steel bridges are very much subdued.

**The First Flat-Slab Railway Bridge.**—In 1912-1913 the first and so far the most extensive application of the flat-slab system for carrying railway loadings was made in Chicago with the erection of the Soo Line Freight Terminal.

The yard area required for this improvement amounted to 18½ acres, comprising 11 city blocks located near the business and manufacturing centers. This entire layout for handling freight is carried on an elevated structure to meet the municipal requirements that no grade crossings should exist. Flat-slab deck construction gave the greatest possibilities of storage development, making available 520,000 sq. ft. on the ground surface underneath the deck for this purpose. The flat slab showed advantages of lower cost, lower maintenance and greater permanence as compared with structural steel. From a railroad point of view the outstanding feature of the design is the possible flexibility in the track layout since the structure is designed to carry any arrangement of tracks on 12-ft. centres. This was obtained with very little additional cost over a fixed position of tracks and driveways. It was in this structure that those responsible for the design decided that no expansion joints were necessary and their judgment seems to have been justified.

**The Lackawanna Terminal at Buffalo.**—The highly satisfactory results obtained with the flat-slab system at the Soo Line Terminal at Buffalo prompted its consideration and adoption by the Delaware, Lackawanna & Western R. R. in the recent construction of a viaduct approach to the station of the new terminal improvement at Buffalo, N. Y. The viaduct, 154 ft. in width and 1,070 ft. in length, supports a structural steel trainshed, platforms, and seven tracks on ballasted floor. For reasons analagous to those cited in the first example, deck construction was admirably adapted to the maximum development of full terminal facilities in a very limited area. This new layout is located alongside the Buffalo River. Docking facilities are for Great Lake steamers which can be unloaded directly under cover of the slab where storage and other shipping facilities, including the express companies, are available. Two tracks are located on the dock level which connect by means of the subway and ramp tracks, with the main line tracks on the upper level. Passenger traffic is discharged on the upper level precluding interference with other station appurtenances best located on the ground level.

The entire structure is supported on timber piles and gravity footings. A precautionary measure was taken to prevent possible movement of piles by connecting all the piers in both longitudinal and transverse direction with reinforced-concrete beam structs or ties, thus insuring lateral stability. Single drop panels connect corresponding columns of bents 1 and 2 to reinforce the end section to take impact transferred from the bumping post which is anchored to the slab. The perfectly flat unobstructed floor simplified the waterproofing treatment which consists of a membrane composed of two layers of cotton cloth saturated and applied with hot asphalt and protected by a cover of asbestos paper and two ¾-in. layers of asphalt mastic. Only one expansion joint was provided and this placed at bent 31 where the slab begins to narrow down from the seven-track to the two-track width at the easterly end. The joint was deemed necessary here for the reason that the narrow section would not offer the same tensile resistance to temperature changes as would the wider section. An accumulation of stress might reasonably be expected somewhere in the narrow section if no expansion joint were provided which might result in cracks of sufficient magnitude to impair the strength of the viaduct.

It might be noted here that the only cracks so far developed have occurred in the side panel under tracks 1 and 2 between bents 24 and 25.

**Flat Slab Construction at Street Crossings.**—In continuation with the improvement through South Orange, and following extensive plans to eliminate all grade crossings through its highly developed suburban sections in New Jersey, the Lackawanna R. R. has elevated tracks through the adjoining city of Orange. Here 23 more or less dangerous crossings have been eliminated. In this work concrete was used almost exclusively in the construction of bridges.

The same advantages that accrue from the use of flat slab construction covering large areas prevail for smaller structures. Fig. 1 illustrates its application to a small type 3-track bridge built on the Orange improvement over Central Ave. 100 ft. in width. Columns on the curb and along the centre line of the driveway divide the deck into eight rectangular panels, two in the width and four in the length of the structure, with dimensions as shown in cross-sections of Fig. 1.

The simplicity of the structural details of the flat slab offers an opportunity to correct the troublesome conditions encountered in bridge abutment construction. The writer calls attention to the abutment development of the Central Ave. bridge which resulted from the conception of maintaining throughout the deck the positive plate action attributable to the flat slab. This was to be effected by an end column support to replace the somewhat complex action in supporting the slab on the full width of the abutment. The columns are set in recesses built in the abutments as shown in sections A-A and B-B, Fig. 1, and also in the isometric drawing of the corner column, which shows the sequence of the construction. The slab is cantilevered beyond the abutment, and built integrally with the slab is the suspended beam or apron which is to prevent the back fill and drainage from percolating through the construction joints. The cantilever has a theoretical significance in giving greater balance in resistance to the negative movement over the columns. The abutment is in fact a retaining walls, since it takes no slab reaction, and it was possible to reduce its section for the reason that the suspended apron of the slab reduces to a considerable extent the live- and dead-load surcharge pressure against the back of the wall. The reduction in concrete is a saving over ordinary concrete bridge abutments and an appreciable saving over the massive abutments required in support of structural steel bridges, where the top width is fixed by wide bearing plates, or shoes, and a back wall. The wide bridge seat retains water, snow and ice, which are sources of much trouble resulting from their marked deteriorating action on the steel and concrete. Here again it is to be noted that the waterproofing details are reduced to the very simplest arrangement.

Relative to the comparison of the cost of structural steel with the flat slab for the small type railway bridge, it has been found in a number of estimates that a very appreciable difference existed in favor of the flat slab. The statement that the cost of structural steel in one case exceeded the cost of the flat slab by 200 per cent may seem somewhat surprising. This result was obtained where deck construction would have been required on account of a yard layout involving crossovers on the bridge, and a shallow floor depth made necessary because of close vertical clearances. The estimate included the price of structural steel at its high-water mark. The appreciable saving augmented by the present high price of structural steel, which is likely to continue for some time, should give added impulse to the consideration of flat-slab construction.

From the standpoint of appearance and quantities involved a specific comparison of the flat-slab bridge can be made with a flat-top bridge, the deck of which is the common slab of rectangular cross-section reinforced in the one direction for continuous action over a series of piers. An example of the latter type spans Waverly Place in track elevation through Madison, N. J. The spans of this bridge are almost identical with the spans over Central Avenue, since here the street is also 100 ft. in width, but the slab reinforced in one direction is 12 in. deeper than the four-way reinforced slab of Central Ave. bridge, exclusive of the drop panel. If this type were used at Central Ave. at the same unit prices, its cost would exceed that of the present structure by 25 per cent. The noticeable advantage of the Central Ave. bridge is the clearer vision beyond the bridge obtainable from all angles of approach.

**Erecting During Traffic.**—The most important consideration in the construction of the small type railway bridge on an established alignment is to maintain traffic without interruption during the operation. This is handled in a number of ways. Where the topography will permit, the alignment is shifted temporarily in order that the bridge might be built clear of traffic, in part or in its entirety. Where the right-of-way is of limited width and the tracks cannot be shifted, a timber pile bent trestle of 12-ft. spans is driven under traffic and between these bents, after the excavation has been made the abutment and piers only of the new bridge can be built. Long temporary through girders are often used to span out to out of the new abutment lines in order that the entire bridge may be built underneath. If no old girders are available and the only solution is the timber trestle there arises the exclusion of the flat-slab construction, for the reason that the floor system of the new bridge must be erected beyond the bridge site, either in units or in the whole, followed by a quick removal of the trestle stringers and the installation of the completed floor system on the new masonry during hours of least traffic.

This very important consideration of construction may be satisfied by dividing the work into two parts along the construction joint. This joint is placed without weakening the strength of the slab and so that one-half can be built first without interference with traffic. The main line tracks there can be shifted temporarily to the completed half which gives clear field for the removal of the old bridge and completion of the new structure. The bulkheads of the construction joint are arranged to be practically normal to the bands of reinforcement.

The measure of the advantage in cost of the flat-slab railway bridge, compared with other types, varies considerably and is dependent upon the conditions at hand. There seems to be no question concerning the architectural and structural advantages, the latter results in less maintenance and greater permanence. Of measurable value is the simplicity of design and the expediency with which the construction can be carried on. Its flexibility offers much opportunity in overcoming and simplifying inherent complications of the small type railway bridge.

## The First Welded Steel Vessel Launched in Great Britain

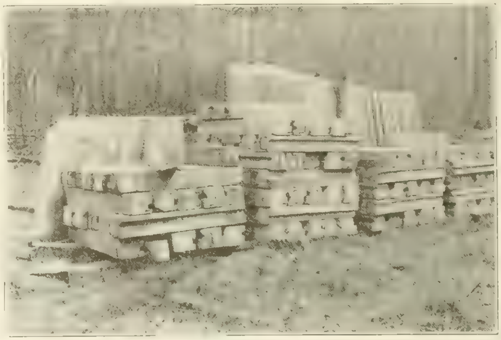
The first rivetless steel vessel built in a shipyard operated by the Inland Waterways and Docks Section of the Royal Engineers of Great Britain was launched last month. The following details regarding this ship are given in a recent U. S. Consular Report:

> Instead of riveting and calking the plates, they are joined together in one process by electric welding. This means that the plates are held together temporarily by bolts, and that the joint is then submitted to local heat by means of an electric arc, so that the two plates are fused together. Though the process itself is not new, as certain auxiliary work on ships has been done by electric welding in the past, considerable developments have been made in the last 12 months, and this is the first time that a vessel has been produced entirely by the new method. Its general adoption would speed up production, more particularly, in the assembly of bulkhead deck structures, fittings, and other interior work. It is computed from the results obtained on this experimental vessel and other admiralty work that a saving of 20 per cent or possibly 25 per cent could be affected in both time and material.
>
> The United States Shipping Board have been in close touch with this experimental work, with the result that arrangements are in hand for the manufacture of a number of 10,000-ton standard ships, in the production of which "riveters" will become "welders." While the first vessel just launched is rivetless, it is calculated that these large vessels will only have about 2½ per cent of the originally intended number of rivets. It is seen, therefore, that in nearly all circumstances the electric welding process can be satisfactorily used. In the vessel just launched the "shell" up to and including the bottom seam of the bilge plate, is continuously welded inside and out. The cross seams are similarly treated. The outside is continuously welded and the inside "tack" welded. "Tack" welding means welding a short section, say, 3 in., and then skipping another section of about twice as much. The frames, floors, deck brackets, and nonwater-tight bulkheads are all "tack" welded; the water-tight bulkheads are continuously welded. In the case of the deck plates, "butt" welding (i. e., the plates arranged end to end, without any overlap) has been adopted. In the construction outlined it is considered that a good margin of safety has been allowed.

## Pre-Cast Concrete Industrial Houses

Workmen's houses constructed of "shop made" concrete have been erected recently for employes of the No. 5 plant of the Alpha Portland Cement Co., at Manheim, W. Va. The houses vary from the 5-room semi-bungalow type to the cottage type of 6 rooms and bath. They were erected by the Simpson-Craft system, which permits the construction of reinforced concrete practically without forms, the greater portion of the work being pre-cast of minimum sections, made with the idea of using common labor in erection.

The construction consists of wall and floor slabs, together with belt and sill courses, floor beams and roof rafters made of standard sections and sizes for individual pieces. They may be assembled in any combination desired, so that while each building is made up of standard units, the general design may be varied, making it possible to produce a large number of buildings, using the standard units, but varying the exterior treatment.



Precast Beams and Slabs.

The pre-cast sections of the buildings are made on casting tables or in moulds. This may be done either at the building site or in the yard or shop, and shipped to the site. If they are shipped, the sections may be packed in fine broken stone, sand or gravel, and the latter may be used at the site as an aggregate forming the studs, which are field-cast and form the binding element for the buildings. All of the pre-cast members entering into the construction are so designed that the metal with which they are reinforced projects beyond the end or edge of the pieces. In assembling the pre-cast sections in the buildings, they are spaced at intervals on the walls, leaving a space between the two sides of sections, and are then clamped together temporarily by means of channel shaped wood or metal forms covering the two open sides of the intervening spaces and forming a pocket into which reinforced bars are placed. The inside face of these pockets has a series of holes spaced about 7 in. on centers, into which are placed large wire hairpins. The pockets formed by the forms are filled with concrete, forming the studs of the building and binding all parts together.

The reinforced concrete beams of the floor construction, which are pre-cast, rest on the top of the wooden forms of the studs, the ends of the concrete beams, with their reinforcements, projecting into the pockets. When the casting is complete, the end of the beam rests directly upon the stud, and is securely anchored.

Upon the removal of the field forms, heavy waterproof building paper is placed against the inside face of the studs, beginning at the ceiling line and working down toward the floor, lapping the paper 4 in. at each joint, and securing the edges to the window and door frames. After this paper has been applied, hy-rib self-centering or other ribbed lath, is placed with the ribs against the paper, forcing the ends of the hairpin through the opening in the lath. Through these openings is then placed a heavy wire or tenpenny nail, and the loops of the hairpin twisted down onto the wire, thus anchoring the lath permanently to the stud. The same method is used in securing the lath to the ceilings, though, if desired, the paper may be omitted.

Completed House. Upper Wall Slab and Part of Floor Beam Are Shown in Foreground

Grounds for the securing of wooden base, picture moulds, etc., are secured to the lath, or "spot" grounds may be used for this purpose; the walls and ceilings are then ready for plastering. Studs for the interior partitions are all pre-cast. Reinforcement for these studs project from the upper ends, the stud being of full height between the top of the floor slabs on which it rests and the under side of the floor beams. Between the top of these studs and the top of the floor beams, a distance of 12 in., is cast a girder or plate, binding the ends of the floor beams together and distributing the load over the studs. This permits of the variations in spacing of the studs for door openings, etc.

Roofs may be formed in a manner similar to the floors, using slabs directly on top of the reinforced concrete rafters. Where cement tile is used for roofing, the tile may be laid directly upon the reinforced concrete roof slabs. For other types of roof covering, dovetailed lath are built into the top surface of the roofing slabs, forming nail spaces for the roofing material.

The foundation walls may be either a solid 8-in. concrete wall on top of a concrete footing, or formed in the same manner as the walls in the building above grade. In the latter case, however, the slabs forming the walls would be 2 in. thick instead of $1\frac{1}{2}$, which is the standard thickness of the wall slabs.

Many designs of surfaces for outside walls may be obtained by the use of selected aggregate. The standard method is to finish the slabs under wood float, touching up the edges of the studs after they have been cast in the field.

Dry joints are used in assembling all the parts, though in casting the studs, all parts of the building are thoroughly grouted, forming a construction analogous to the placing of panels in the doors.

## To Utilize Colleges to Maintain Reservoir of Officer Material

Plans for organization of a student army training corps in the educational institutions of the country to train men as officers and technical experts in the army were approved last week by Gen. March, chief of staff, by order of the Secretary of War. The plan will utilize the plant, equipment, and organization of the colleges to maintain a reservoir of officer material for training.

The length of time during which men will be trained in the colleges will depend upon the needs of the service. As fast as one group is drawn into the service its place will be taken by a new quota obtained by voluntary induction or through the draft. In this way the educational facilities of the country will be used to maintain a constant supply of men trained to meet the needs of the army.

Under the regulations provided for the student army training corps selected young men who are physically fit for military service, who are 18 years of age or over, and who have had a grammar school education, may voluntarily be inducted into the army and enter upon a course of special training. Those who have had a grammar school education, but no more, will ordinarily enter special training detachments to be trained along mechanical lines of military value. These detachments will become a part of the student army training corps and young men who prove in the course of their mechanical training that they are officer material may be transferred to a unit in one of the colleges to be prepared to enter a central officers' training camp.

Young men who have had at least a high school education will be allowed to enter the colleges for more advanced training as officers and as technical experts of various kinds, according to their experience and ability.

Those men who show promise under this training will be kept in college until qualified to enter central officers' training camps or to go directly into the service as technical experts. Those who do not will be sent either to a noncommissioned officers' school or to the nearest depot brigade, or, in case they show special technical or mechanical ability, to the detachments where men are trained for such work.

# Selecting an Economic Paint*

By ROBERT JOB.

Paint is described, in a general way, as the mixture of finely-divided particles of solid matter, called the "pigment," in a liquid, called the "vehicle." Asphalt paint is merely solid asphaltum dissolved in benzine or some other vehicle.

The "pigment" functions to hide the surface over which the paint is applied, to resist the action of weather and wear, and give color. The selection of the most suitable pigment or combination of pigments depends very largely upon the relative importance of these functions under the conditions for which the paint is intended to be used.

The "vehicle" functions as the carrying and cementing body, and dries and binds together the solid particles of pigment in somewhat the same way that portland cement and water unite sand and broken stone to form concrete.

The study of paints was given great impetus, about 1890, through the published investigations of Dr. Charles B. Dudley, for many years the able, widely-known, and respected chemist of the Pennsylvania Railroad. In his studies, among other things, the properties of paint materials were systematically investigated, and what was learned brought about radical changes in the composition and manufacture of paints. The Pennsylvania Railroad gained much valuable information as the result of Dr. Dudley's work. It was clearly realized, for example, that the effectiveness of a paint did not by any means depend upon its cost per gallon or pound. As a matter of fact, it was proven that some of the most durable paints could be obtained at a minimum cost.

**Size of Pigment Particles.**—The size and form of the particles of the pigment were shown to have a great influence upon the life of a paint coating, though this subject had not previously received any attention. A brief description of a case that clearly illustrates this point may be of interest:

Two bridge paints had been used upon the lines of the Philadelphia & Reading Ry. for a period of about 10 years. These paints were made by the same manufacturer, and contained almost the same proportions of the same materials. Though they were exposed side by side and under like conditions all along the road, one of them became known for its good service and the other for very poor service. The life of one was twice that of the other. The difference between the service rendered by these paints was so marked that we determined to get at the real causes, so as to bring the quality of all our paint deliveries to the same high standard of durability represented by the better paint. The discovery that the main difference between the two paints was in the relative size of the particles of the pigments resulted from this investigation. In the long-lived paint these particles ranged from two to ten ten-thousandths of an inch in diameter, with comparatively few of the maximum sizes, while in the short-lived paint the diameters ranged from two to one-hundred and eighty ten-thousandths of an inch.

The average diameter, as nearly as we could estimate, of the particles of the pigment of the satisfactory paint was four ten-thousandths of an inch, against eighty ten-thousands of an inch for the unsatisfactory paint; and, as the volumes of spheres are to one another as the cubes of their diameters, it follows that the average particle of the pigment of the good paint was eight thousand times smaller in volume than that of the bad.

The composition of these two paints was about 75 per cent, oxide of iron, combined with inert matter, such as clay and gypsum, as a filler, ground in pure linseed oil, with a small proportion of Japan drier, as a vehicle. The details of the investigation may be found in the Journal of the Franklin Institute for July, 1904.

The reason why this difference in the size of the particles of pigment makes so marked a showing in the service of the two paints is that where the particles are coarse, relatively large oil spaces surround them; and as linseed oil is by no means waterproof, as we have mentioned, the effect of the weather is soon noticed in such paints. Surface tension also operates in favor of the paint having the finer-particled pigment, on the same principle that fine sand, when wet, holds together, where coarse sand or gravel will not.

These tests demonstrated that some of the most durable paints were composed of the simplest and least expensive of pigments, and created a good deal of interest because the findings ran counter to the preconceived idea of many who had assumed that in order to be really good and give long service a paint must be composed of one of the more expensive pigments, such as white lead, and that those which contained the so-called "inert materials" were to be looked upon as "doped" products. Because of misbranding and wholesale and indiscriminate adulteration the manufacturers were, in some cases, to blame for this. For example, we have seen a supposedly oil paint that contained 30 per cent of water. Another paint labeled "pure white lead" contained no white lead. Many other cases could be cited, and it is small wonder that such abuses led to a public outcry and legislation that was sometimes carried too far. It became necessary, because of these conditions, to determine the truths about the properties and characteristics of the different paint materials, and the work was finally undertaken by the Scientific Section of the Paint Manufacturers' Association of the United States. A fence was built at Atlantic City and several hundred panels were coated with paints of different formulae in order to determine the value under exposure to the weather at the sea shore of the more important materials used as pigments, and also to show the most durable combinations of the various pigments under such conditions. Exposures were made on both iron and steel panels as well, and, subsequently, test fences were erected in other parts of the country in order to get varying climatic conditions. The tests were made under the supervision of the American Society for Testing Materials, and a vast fund of information regarding the service value of various compositions and combinations was obtained. Materials that many considered as adulterants not long ago are now known to have a definite value in the design of high-grade paints.

Misrepresentation still exists under the stress of competition, but the general plane of the paint industry is distinctly better, for the simple reason that the principles of manufacture, the relation between cause and effect as applied to paints, and the properties of paint materials, are all far more thoroughly understood than was the case even at the beginning of the twentieth century.

**Paint Specifications.**—It will be clear from what has now been said that in order to be serviceable a

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From a lecture delivered in the Extension Course on Industrial Chemistry at McGill University.

paint must be composed of a pigment that is of a character well adapted to the conditions under which it is used; that this material must be in the most effective physical condition, and must be carried in a vehicle which will form an effective bond between its particles, and at the same time be as nearly weatherproof as possible.

The spreading quality is a factor that should be very carefully borne in mind when purchasing paints. That paint having the pigment composed of the most finely divided particles, other things being equal, will spread farthest. Specific gravity is another important factor, and should be studied accurately by the purchasng agent who is buying by the pound. The paint of the least specific gravity will be the greatest in bulk; and it is bulk, not weight that counts in determining the spreading capacity of paints. The labor cost of applying the paint is usually far greater than the cost of the paint itself; and it is important to remember this as a special incentive for the purchasing of the most durable paint for the purpose.

Specifications for various types of paints were the natural outcome of all the foregoing investigations and experiments with paints and paint materials. Such specifications have been drawn by the writer and others to cover paints for use under many different conditions, and these can be filled by any manufacturer who is willing to give care and attention to the work. Some of them, in fact, now carry these preparations in regular stock.

By purchasing wisely, under carefully-drawn specifications, real competitive prices that represent the true market value of the paint materials, plus a reasonable allowance for the costs and profits of manufacturer, can be secured.

Marked economies have been effected by some of the principal railroads and by many smaller users of paints, through lowered costs and increased service, as a result of working along these lines. Large purchasers know they cannot afford to do otherwise than buy according to specifications specially drawn to cover the needs of the service. It would be much to the advantage of many of the smaller purchasers who use quantities that would warrant the small expense connected therewith if they would do likewise.

Final testing is, of course, absolutely necessary, for it is useless to buy according to specifications, or even on promises, unless the paints actually delivered are tested to determine whether they are as spcified or represented.

**Engineers, Town Planners and Architects Appointed for Industrial Housing Projects.**—The Bureau of Industrial Housing and Transportation announces the following appointments in connection with projected housing developments: Staten Island, N. Y.—Architects, Delano & Aldrich, 126 East 38th St., New York City; town planner, A. F. Brinkerhoff, 327 Fifth Ave., New York City; engineer, C. S. Pollock, Park Row Bldg., New York City. Florence, Ala.—Architects, Warren & Knight, Birmingham, Ala.; town planner, Harold A. Caparn, 220 West 42nd St., New York City; engineer, Julian Kendrick, Birmingham, Ala. Sheffield, Ala.—Architects, Warren & Knight, Birmingham, Ala.; town planner, Harold A. Caparn, 220 West 42nd St., New York City; engineer, Julian Kendrick, Birmingham, Ala. Tuscumbia, Ala.—Architects, Warren & Knight, Birmingham, Ala.; town planner, Harold A. Caparn, 220 West 42d St., New York City; engineer, Julian Kendrick, Birmingham, Ala.

# Economic Life of Office Buildings

An examination of the older office buildings in any city will convince almost any one that the economic or commercial life of such buildings has not exceeded 40 years, stated Mr. Edward A. Renwick of Holabird & Roche, Architects, in a paper presented at the recent convention of the National Association Building Owners.

Many of us, continued Mr. Renwick feel that with the advent of the modern skeleton construction, which had its birth in Chicago in 1887, the climax has been reached in construction and that these buildings will last at least 100 years—physically they may last 200, but it is doubtful if they will have great economical value when 40 years old.

Every year we see buildings 25 to 35 years old being replaced with new structures because their commercial life has ended, although perhaps they are still in good condition physically. Some of these when built were the best that could be produced with the engineering and architectural talent of the day, but new devices and methods of construction or changes in business requirements have destroyed them as competitors against these more modern buildings.

There are a number of modern fireproof buildings that have been taken down to make room for larger or different classes of buildings, because these removals made the land more productive by the change, even though the cost of the original structure was added to the value of the land. Of course, had the owner been wise enough to have foreseen the new requirement and designed the building so it could have been readily converted to the new use, its commercial life would have been extended, but such provision would have added a considerable burden to the cost.

How can we best provide against this economic loss? The answer, stated Mr. Renwick, seems to be to set aside a sum for depreciation annually and invest it and its accrued interest in safe securities. The average owner feels that this depreciation will be offset by the increase in the land values, but to benefit by such increase, a sale must be made. Would it not be far wiser to set aside a fund and invest it in 4 per cent securities and thus, when serious changes are required to prolong the life of the building, the funds will be at hand to do so, and thus revive the economical life and check the rapid depreciation with consequent lowering of the character of the tenants. If a sum equal to 1 per cent of the cost of the building is so set aside annually and invested at 4 per cent and the interest reinvested at 4 per cent, it will equal the cost of the building in 40 years.

**Five Hundred-Ton Concrete Barges Now Being Built for Barge Canal.**—Contracts for 21 500-ton concrete barges to be used on the New York State Barge Canal have been awarded at an average price of $25,000 each. The contractors are: Holler-Davis & Flood Co., Fort Edward, N. Y., 8 barges; Thomas & Currie, Detroit, Mich., 5 barges; Caldwell-Marshall Co., Tonawanda, N. Y., 4 barges; Cummings Concrete Constructional Engineering Co., Ithaca, N. Y., 4 barges. The barges were designed by the Government Department of Concrete Ship Construction for the Inland Waterways Committee of the Railroad Administration. They are to be delivered by Dec. 1, 1918.

# Canadian Tests on Flat-Slab Construction

In "The Canadian Engineer" of March 28 a five-page article gives the results of extensometer tests on the reinforced concrete flat-slab floor of the Robert Simpson Bldg., Toronto. The article is by W. W. Pearse, City Architect and Superintendent of Buildings, and Peter Gillespie, Asso. Prof. Mechanical Engineering, University of Toronto.

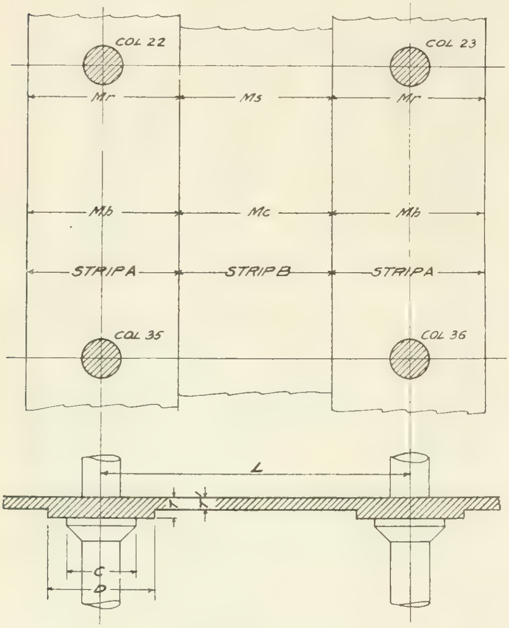

Fig. 1.

Due to cracks that developed around the columns under the loading, it was necessary to subdivide the panel into strips, find the moment of inertia of each strip and add them together. This gives only a very rough approximation at best, which must be borne in mind in considering the results of the tests.

The first load applied was 135 lb. per square foot. The second load was 270 lb. per square foot, when bad cracks developed around the capital heads of the columns. This is attributed to the fact that the steel was too far below the top of the column, the distance being 3½ in. An area covering four panels on the seventh floor was tested with the results shown in Tables 1, 2 and 3. Fig. 1 shows the position of the "strips" referred to in the tables.

The following symbols were used:

$L$ = distance c. to c. of column, in feet.
$w$ = total live and dead load per square foot = 135 + 113 = 248 lbs.
$W$ = total panel load in lbs. = $wL^2$.
$s$ = tensile stress per square inch in steel.
$c_t$ = extreme fibre tensile stress per sq. in. in concrete.
$c$ = extreme fibre compressive stress per square inch in concrete.
$I$ = moment of inertia.
$Q_t$ = section modulus for side in tension.
$Q_c$ = section modulus for side in compression.
$E_s$ = modulus of elasticity of steel = 30,000,000.
$E_c$ = modulus of elasticity of concrete in compression = 3,500,000.
$E_t$ = modulus of elasticity of concrete in tension = 2,800,000 (assumed as $\frac{8}{10}E_c$ same as used for Wm. Davies Co. Building, Toronto).
$M$ = Bending moment.

In discussing the question of unbalanced thrust Prof. Gillespie says:

No other type of reinforced concrete construction has appealed to the building public or has caught the popular fancy as has that commonly described as the flat slab or girderless floor. The resulting economy in story heights, the simplified form construction, the unbroken ceilings and the ease with which auxiliary equipment as, for example, sprinkler systems, can be installed have all contributed to that popularity. But while these advantages have been generally recognized, the difficulties attending the rational design of flat slab structures have also been appreciated because this type does not lend itself to either simple or satisfactory theoretical treatment. Recognizing this, public-spirited firms and organizations have provided facilities whereby tests of full-size buildings have been made with a view to studying the behavior of floors under the load and thereby formulating empirical rules for the design of flat slabs which, when constructed, would be safe without being wasteful. These tests have usually consisted in applying to the floor a live load equal to or exceeding that for which the structure was built and then measuring the deflections and the deformations in the steel and concrete at certain selected places in order to determine the intensity of the stress resulting. From the nature of the work some form of portable extensometer was necessary and for this, that known as the Berry strain gage or some modification of it, has generally been used.

| Code | Strip A | Strip B | Mr | Mb | Ms | Mc | C† | D† | T† | T'† |
|---|---|---|---|---|---|---|---|---|---|---|
| Chicago | $\frac{L}{2}$ | $\frac{L}{2}$ | $-\frac{WL}{30}$ | $+\frac{WL}{80}$ | $-\frac{WL}{120}$ | $+\frac{WL}{120}$ | .225L | .33L | | 6" or $\frac{L}{32}$ |
| Philadelphia | $\frac{45}{100}L$ | $\frac{45}{100}L$ | $-\frac{WL^*}{28.9}$ | $+\frac{WL}{94}$ | $-\frac{WL}{155}$ | $+\frac{WL}{144}$ | .2L | .38L | $1\frac{1}{3}T'$ | |
| Joint Comm.tee | $\frac{L}{2}$ | $\frac{L}{2}$ | $-\frac{WL}{25}$ | $+\frac{WL}{55.5}$ | $-\frac{WL}{100}$ | $+\frac{WL}{133}$ | .2L | .4L | | 6" or $\frac{L}{32}$ |

*Mr for steel in straight band is $\frac{WL}{34}$ and for steel in diagonal band $\frac{WL}{72}$.
†C, D, T, T', are minimum dimensions allowed by Codes.

**Table 1—Comparison of Recommendations of Chicago and Philadelphia and Joint Committee Report**

| | At edge of Capital | | | | | | Strip A at Centre | | | Strip B at Centre | | | | | | | | Strip B at ℄ of Cols | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reading No. | 710 | 713 | 717 | 601 | 607 | 614 | 656 | 662 | 663 | 657 | 658 | 659 | 660 | 785 | 786 | [illegible] | 801 | 784 | 583 |
| Stress in | Steel | Steel | Steel | Conc | Conc | Conc | Steel | Steel | Steel | Steel | Steel | Steel | Steel | Conc | Conc | Conc | [illegible] | Steel | Conc |
| Chicago Code | 5900 | 15040 | 15570 | -658 | -592 | -635 | 18000 | 16080 | 16080 | 17880 | 16350 | 16350 | 17880 | -326 | -390 | -326 | -390 | 13270 | 357 |
| Philadelphia Code | [illegible] | [illegible] | [illegible] | -695 | -626 | -671 | 15310 | 13690 | 13690 | 14890 | 13610 | 13610 | 14890 | -302 | -361 | -302 | 361 | 10270 | -307 |
| Joint Comm.tee Report | 9600 | 18450 | 19100 | -789 | -710 | -762 | 25950 | 23160 | 23160 | 11500 | 10530 | 10530 | 11500 | -294 | -352 | -294 | 352 | 15900 | -428 |
| Test | 5925 | 4680 | 2066 | -176 | -676 | -562 | 3860 | 6480 | 7720 | 7240 | 7110 | 1504 | 2190 | -574 | -717 | -685 | 557 | 3960 | -319 |

**Table 2—Comparison of Stresses for Live and Dead Loads Combined According to Various Codes, with Those Found by Test. Stresses are in Pounds Per Square Inch**

| | Strip A at edge of Capital | | Strip A at Center | Strip B at centre | | | | Strip B of ℄ of Cols | |
|---|---|---|---|---|---|---|---|---|---|
| Reading No. | 710, 713, 717 | 601, 607, 614 | 656 | 657-8 | 659-60 | 785-6 | 800-1 | 784 | 583 |
| Stress in | Steel | Concrete | Steel | Steel | Steel | Conc | Conc | Steel | Conc |
| Chicago Code | 5020 | -357 | 855 | 750 | 750 | -200 | -200 | 2890 | -176 |
| Philadelphia Code | 5300 | -377 | 727 | 900 | 900 | -185 | -185 | 2240 | -151 |
| Joint Comm.tee Report | 6150 | -428 | 1231 | 483 | 483 | -180 | -180 | 3460 | -210 |
| Test | 4230 | -476 | 3860 | 7175 | 1847 | -645 | -622 | 3960 | -319 |

**Table 3—Comparison of Stresses for Live and Dead Loads Combined According to Various Codes, with Those Found by Test Using the Section Modulus Determined by Deformation Readings**

Any type of extensometer which has to be attached to a specimen and removed again between readings cannot possess the accuracy of measurement usually obtained from the stationary forms. Then, again, concrete is a material for which the ratio of stress to deformation is much more variable than it is for the metals. Moreover, for any given concrete and for all stresses above moderate working values, Hooke's law of proportionality between stress and strain does not obtain. Further, it is usually quite impossible to know at just what stage of the operation of loading, the concrete in tension will crack and throw upon the reinforcement the bulk if not all of the tension which it has been carrying. In consequence of these limitations it will be conceded that the figures obtained from the use of the portable extensometer, especially on concrete structures, must be interpreted in a broad and liberal manner and that they must not be considered as reflecting the last refinement of physical measurement. It should be noted, too, that the inevitable errors are probably relatively greater for small deformations than for large since the ratio of a probable error to a large deformation is less than to a small one.

With respect to the Simpson Building test, there is one point to which attention may be called because it relates to a phenomenon which has been observed in several previous tests and is one which concerns the values to be assigned for the working stresses in both materials. To illustrate, Fig. 2 has been prepared for the test data. It will be seen that the various values of the observed deformations for the several gage lines lying diagonally in one direction from column 23 have been plotted with respect to a horizontal axis, elongations upward and shortenings downward. Whether these relate to steel or concrete does not concern us, since it is to only one position on this radial line that attention is invited. Generally speaking, when either line crosses the horizontal axis, it denotes a point of zero deformation and therefore a point of zero flexural stress and of zero bending moment. If both lines cross the zero axis at the same point, it denotes a true point of contraflexure at which the stresses are mainly shears. In Fig. 2, however, this is not the case and for some distance outward from gage line 715, the slab appears to be altogether in compression, and at gage line 610; this, according to the records, is equal to an average stress of 70 lb. per square inch with a resultant acting much nearer the lower face than the upper. Moreover, in this particular region, the situation is not complicated by the presence of three or four superimposed layers of metal such as are found in some other places. This phenomenon is probably due to the partial behavior of the slab as an arch, an hypothesis, indeed, for which there is considerable warrant, since the peculiarity has been observed and reported on several occasions.

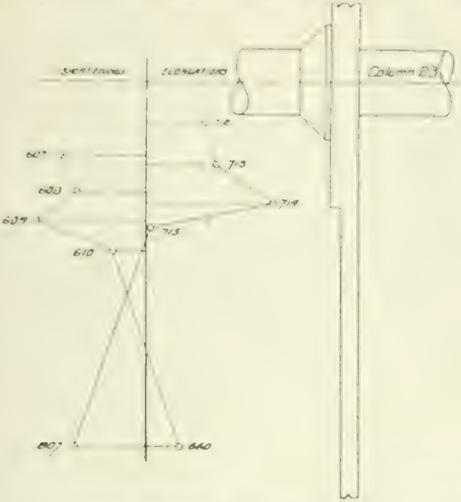

Fig. 2.

Top of slab shown thus ———
Bottom of slab shown thus — -

## Crew Erects 75 Frames for Ferris Type Hull in 37¼ Hours

A crew of 62 men of the Sanderson & Porter shipyard at Raymond, recently built, set and plumbed 75 frames on a Ferris type hull of a wooden ship in 37 hours and 15 minutes. The number of frames erected in consecutive shifts of 8 hours was as follows:

| | Frames |
|---|---|
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| Total | [illegible] |

The total number of men employed on this job was follows:

| | |
|---|---|
| [illegible] | [illegible] |
| Fasteners | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| Total | [illegible] |

In addition to the frames on the job. the crane also handled material for an adjacent hull, upon which three ceiling crews were working.

**Don'ts for Steel Workers.**—The following "safety first" suggestions are taken from the "Heave Together," a publication of the Northwest Steel Co.: Don't throw rivets carelessly; don't pass under sling or crane loads; don't leave tools or material on staging; don't fail to keep all safety guards in place; don't violate your employer's safety rules; don't fail to keep clear of lines and blocks; don't injure your fellow worker by your carelessness; don't go onto a staging unless you are sure that same is safe; don't sit or lean on safety rails or braces, they sometimes break; don't throw anything from staging—you may hurt someone below; don't fail to wear goggles, when required—you may lose your eyesight; don't carry spud bars, wrenches, drift pins, bolts or rivets in your pockets; don't jump from one staging to another—there is always a way around; don't fail to examine all hooks, slings, and other rigging before using them; don't use defective tools—your foreman will furnish you with proper ones; don't fail to report to your foreman when staging or rigging is in need of repairs.

**Progress Photographs of Shipyard Taken from Crane.**—The Groton Iron Works, Groton, Conn., has developed a well organized system of making progress records of its shipbuilding work by means of photographs. It has been found that by taking as near a bird's-eye view as possible from the cranes excellent progress photographs are obtained. A boatswain chair is fitted at the end of the crane for the photographer. For this purpose the crane is used only for 5 minutes at each end of the craneway at noon, two views of each of the ships adjoining being taken.

# Notes on Office Building Design*

By EDWARD A. RENWICK,
Holabird & Roche, Architects, Chicago.

**Column Spacing.**—The plan of the building should have the best possible column spacing for both offices and stores. In a building 10 or more stories in height the spacing for offices should take preference over that for stores, as the combined square feet net rental of the office floors is generally greater than the net rental per square foot of the stores. The best width and depth of offices should be determined. Numerous studies of the typical upper floors plans should be made to obtain the maximum rental of perfectly and permanently lighted space, with the minimum of building area of the typical floor. These studies should be analyzed by percentages to compare results. In making such studies, consideration should be given to the effect of climate, prevailing winds, sun, air, light, width of street, expanse of parks, water or other natural conditions affecting light in offices, and also consideration of the requirements of the possible occupants.

It has been found that offices facing the lake on Michigan boulevard in Chicago can be well lighted to a depth of over 30 ft. by the reflected light from the water—this light being nearly horizontal, and advantage has been taken of this condition in the planning of certain buildings.

**Corridors and Courts.**—The plans should permit the entire floor to be thrown into one unbroken space of tenants requiring such space. The ability to cut off large, unbroken areas for single tenants is desirable, as it saves corridors, increasing the renting areas and reducing initial cost and also reduces the operating expense. The location of the court, or courts, is of vital importance; generally one large court is better than two or more smaller ones. The building should have such ample courts that the light would still be very good should buildings of equal or greater height be erected adjoining the site. The custom of depending on the light from an alley which is 16 ft. or 18 ft. wide is objectionable, for ample light in such a case is impossible if the building opposite is high, or if such buildings should be built in the future. In good planning the court will be combined with the alley and thus increase the light and air.

Interior columns should be placed near the corridor lines to facilitate subdivisions into larger than unit spaces. The window arrangement should be such that every square foot of rentable space will be perfectly lighted, and the windows should be divided by mullions and piers so arranged that the greatest flexibility in subdivisions may be possible.

**Elevators.**—The elevators are of great importance to the success of the building. The number should be sufficient for the peak load, but this peak load is subject to great variation, caused by the character of the tenants. Those tenants who occupy large spaces and have a numerous clerical force, such as railways, large manufacturers, schoolboards, etc., seriously affect elevator service. Unless arrangement can be made between owner and tenant providing that the employes leave and arrive, particularly at the noon hour, in regulated relays, the elevators, which during practically all other hours of the day are more than ample, may become inadequate. This always reflects on the minds of the public and affects the reputation of the building. The use of the upper floors for clubs, particularly lunch clubs, has this same effect.

Elevators should have good speed, be equipped with signals to reduce stops to a minimum and thus conserve both time and current. The elevator cabs should always be as wide as they are deep, and in most cases should be from 20 to 50 per cent wider than they are deep. The doors should open to two-thirds of the width of the cab. This insures quick filling and emptying of cabs, and conserves time and thus reduces the total of service. For the ordinary office building cabs that will hold 12 to 14 people will show the best results, rather than larger or smaller cabs. Thus the cabs will have from 28 to 32 sq. ft. of area inside measurements, arranged 4 ft. 8 in. deep by 6 ft. to 4 ft. deep by 7 ft. wide.

The number of elevators depends on the total square feet of renting space above the first story modified by the class of tenants and the relative size of the offices; the maximum number should be based on 20,000 sq. ft. of renting area per elevator and the minimum on 27,000 sq. ft. In both cases this only applies where the total renting area exceeds 60,000 sq. ft. The height of the building also affects the rule. The building should have not less than two elevators regardless of the total renting area, so that in case of a breakdown of an elevator the service will not be greatly impaired.

**Interior Treatment.**—The interior treatment of the buildings to a large degree determines its character and also its worth as an investment. The building that has durable finish and is a little better finished and equipped than its neighbors, will not be outclassed so rapidly by newer structures, and will have a larger commercial life. The tenant is affected mostly by the appearance of the elevator lobby, corridors, public utilities and finish of his offices, the character of the plumbing and heating, arrangement of lighting outlets, conveniences to elevators, stairs and public utilities.

The rentals obtainable in a locality must be the deciding factor in selecting the finish of the building. Certainly the standard of finish of a building where $1.25 to $1.50 per square foot is to be expected, must be lower than where higher rentals prevail. There is a simple rule that governs most successful buildings.

**Rentals.**—The rentals of the first story and basement should pay the taxes on the land, 5 per cent interest on the land (or the ground rent in case of a long term lease) and the insurance on the building as a minimum. It will then appear that when the minimum only is obtained, the upper stories must be leased for $1.25 per square foot to pay a small return on the most economical building possible. This seems a fair rule as an analysis of rentals on various streets in cities where first story rentals vary greatly, the office rentals are usually about the same and the high first story rentals occur where the land value is highest.

Comparing the buildings in New York City with those of the West, one is impressed with the greater economy in the upper floors obtained in New York City. We of the Middle West have been more extravagant in this regard. With the certain increase in the cost of buildings for many years to come, together with the probable increase of cost of operation, economies must be practiced, and at the same time the results must not appear cheap.

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*From a paper presented at the annual convention of the National Association of Building Owners and Managers.

# Method of Numbering County Bridges and Making Bridge and Drainage Map

When the present road and bridge laws of Iowa were enacted there arose a need in the various counties of the state for a more accurate system of bridge and road designation. The information required under the new law made it desirable for each county to adopt some system whereby each bridge could be definitely located or numbered and records of cost, construction data, etc., kept of it. In the Service Bulletin of the Iowa Highway Commission, Mr. J. C. McLean, County Engineer of Woodbury County, gives the following outline of the methods used in the field and office work on a bridge map for his county, which involved gathering data from 23 townships covering an area of approximately 840 square miles.

**Field Work.**—The county was divided in six districts for the field work, five of which consisted of four townships each, and the sixth the three flat townships along the Missouri River. A field party was placed in each district consisting of an automobile driver, and recorder, together with such tapes, maps, notebooks, etc., as were required for their use. The general plan used in collecting the field data was to take one township at a time and complete it so arranging the route traveled that every mile in the township would be covered with as little duplication as possible. Township line data were taken only on the north and east lines except in the case of an adjoining county where the south line was also taken. In this way there was no overlapping of routes, and each mile was covered only once.

**Recording of Field Data.**—A sample form of the field notes showing the nature and extent of the data taken is shown in Fig. 1.

One sheet was used for each bridge or culvert, and the recorder after making his entries would mark a cross such as is shown at "A" in the figure, at the exact location of the bridge in the given mile. This could be done quite accurately, as the section used in the field notes was drawn to a scale of 1½ in. to the mile. Each section is divided into quarters, which aided greatly in definitely locating the position in the mile and tracing the streams through a given section. After locating the bridge on the mile the recorder would then by eye trace and record the course of the stream in and out of the bridge as far as he could see in either direction, noting the direction of flow, and the point where it crossed the quarter at section lines as the case might be.

In case of any draw crossing the road with no bridge or culvert spanning it, a similar record would be made to scale, showing the point where it crossed the road and the nature and extent of the drainage.

In addition to the bridge data, all cemeteries, schoolhouses, churches, road changes, ditches, laterals, gravel pits, etc., were recorded in their respective locations and to scale. Taking data of this kind required as a rule between 4 and 5 days per township for one party at a cost of $6 per day for car and driver, $4 for an assistant and about $3 for expenses, making a total cost of $13 per day or between $50 to $60 per township.

**Scale, Legend and Numbering.**—A scale of 2-in. to the mile was adopted for the final map; this size was found to be sufficiently large for the requirements and very convenient for field use. Four symbols were used for the bridge designation as follows:

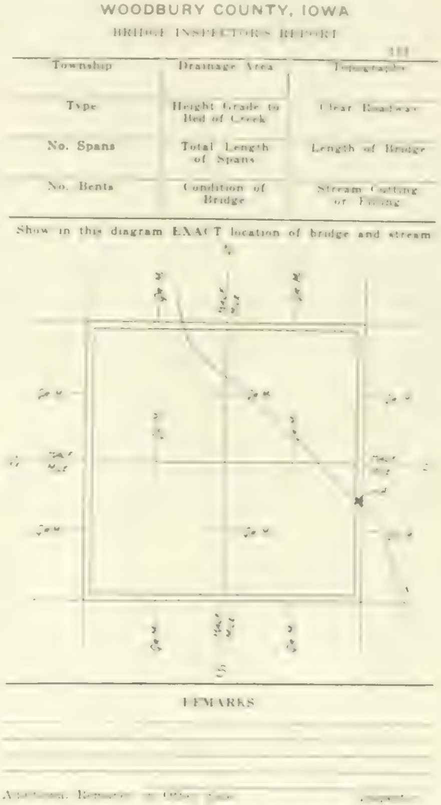
Permanent Bridges—Circle with small black square inside and two lines extending through it forming a cross.

Permanent Culverts—Circle with black square inside.

Temporary Bridges—Small black square.

Temporary Culverts—Small hollow square.

Spans 16 ft. and over were classified as bridges, and under 16 ft. as culverts. It will be noted that these symbols are convertible, for instance a temporary bridge is built and is later changed into a permanent type, this change can be made on the map by simply the addition of two lines and a circle to the temporary symbol. Likewise to change from a temporary culvert to a permanent culvert it is only necessary to fill in the center of the temporary symbol and inclose it in a circle.



WOODBURY COUNTY, IOWA

BRIDGE INSPECTOR'S REPORT

| Township | Drainage Area | Topography |
|---|---|---|
| Type | Height Grade to Bed of Creek | Clear Roadway |
| No. Spans | Total Length of Spans | Length of Bridge |
| No. Bents | Condition of Bridge | Stream Cutting or Filling |

Show in this diagram EXACT location of bridge and stream

REMARKS

Additional Remarks on Other Side

Fig. 1—Sample Form of Field Notes.

The system of numbering adopted provided each township with a letter of the alphabet as a key which will be used to designate that particular township. The numbering of the bridges began in each case in the northeast corner of the township, thence west on the first tier of sections to the township line, thence east again to the township line, the numbers increasing progressively from the northeast corner. Additional bridges which will be added from time to time will be given the number of the bridge in the section nearest them with numerals prefixed. Thus for an additional bridge near L62, would be L62-1, L62-2, etc.

No attempt was made to either number or locate the farm entrance culverts. Where well defined draws crossed the road with no bridge a number was given them, and a corresponding blank left in the map at this point.

**Index of Bridges and Field Sheets.**—The data taken on each bridge in the field were transferred in the office to a card index system, classified according to townships. In this way a definite and detailed record of each bridge is kept on file which it has been found greatly facilitates designing new work.

For field purposes a general tabulation sheet of each township was prepared, giving the number, type, length and height of each bridge in the township. This tabulation is printed on the reverse side of the corresponding township map using the duplex system of blue line printing. In this way there is available for field use the general dimensions and types of all bridges in the county. This feature has been found to be very convenient, especially in repair work in determining the length of piling necessary for a given bridge, or the number of floor plank needed.

**Office Map.**—A large wall map has been prepared for office use by assembling the individual township maps on a scale of 2 in. to the mile. On this map will be shown all the waterways in the county fully developed whether bridge or not, and from it it should be possible to obtain with a fair degree of precision the drainage at any particular bridge.

## Light Weight Concrete to Be Used in Constructing Cargo Ships at Houston

Gravel aggregate producing concrete lighter than normal will be used in the building of two concrete cargo ships at the Houston, Tex., shipyard of the marine department of the Houston Bank & Trust Co. The ships, each 2,000 long tons deadweight capacity, will be constructed for the Pan-American Trading Co. The boats were designed by Mr. E. Lee Heidenreich, Kansas City, Mo. Their dimensions are:

| | |
|---|---|
| Length between perpendiculars | 240 ft. |
| Length over all | 250 ft. |
| Breadth, moulded | 32 ft. 6 in. |
| Depth to top of main deck | 21 ft. 6 in. |
| Heighth between deck | 7 ft. 6 in. |
| Designed load draft | 16 ft. 0 in. |
| Dead rise | 6 in. |
| Sheer forward | 3 ft. 9 in. |

The vessels will be single screw steamers, and will have a speed of 10 knots. They will cost about $400,000 each.

**Army Establishes Construction Lumber Depot.**—To save time and money in meeting emergency calls for lumber, the Construction Division of the Army has established a construction lumber depot at Gilmerton, Va. It is estimated that a yearly saving of approximately $250,000 will be effected through its operation. In the past, whenever the Army constructors were requested to buy additional lumber, the transaction was made at yards in the immediate vicinity. The average increase in price for this material over the lumber originally purchased for the job ran from $9 to $12 per thousand feet. By purchasing in large quantities and charging only for yard maintenance, the greater part of this excess price is expected to be saved to the Government. A stock of from 12,000,000 to 15,000,000 ft. of lumber will be carried and it is estimated that the yearly turnover will amount to between 50,000,000 and 60,000,000 ft. A fund of $500,000 has been set aside as necessary working capital for the yard.

## Practical Points in the Design and Construction of Partitions*

By H. L. BARRACLOUGH,

Like many other things, the war has brought partitions into an almost endless number of uses, one of which has been for the building of huts and houses. Though this may be new to some, the writer has been concerned in the building of schools and sanitoriums with plaster slabs, cement rendered outside, and those places stand today as good as when erected.

Simple, as it may seem, the erection of partition slabs, as experience has proved, should be entrusted only to the hands of men used to this particular class of work. A badly built-up job is sure to develop cracks in unthought-of places, the blame very often being fixed on the manufacturer of the particular partition slabs. This long-suffering individual very often has little means of replying to the criticisms, where the slabs alone are supplied by him.

There are several kinds of partition slabs manufactured and on the markets—breeze, pumice, plaster and clay—each of which has its special claims.

Plaster, until recently, has been the most common in use, and has many advantages over breeze slabs. Solid plaster slabs are light, easily fixed, with little or no waste in erection. When up, they form a solid wall, hygienic in all ways, as every possible lodgment for dirt and vermin is effectually closed after the walls have been plastered out, and are fire and sound-resisting, provided the work has been executed by skilled labor, which goes largely to ease the question of after-cracks.

My opinion is that hollow plaster slabs, although lighter, have some objectionable features, the compressional strength of the slab having been somewhat destroyed through the apertures; and further, if spiking is resorted to for fixing, very often the spikes crack the slabs when being driven in, and generally weaken the whole wall.

In fixing plaster partition slabs, it is essential that the suction should be destroyed by applying a thin cement wash, and that they should be well bedded in plaster in preference to spiking.

It is preferable that all slabs, used for partition work, should be tongued and grooved horizontally and vertically, and, in fixing, the grooves should be placed upwards and the joints broken, as in brick work, and the vertical joints carefully grouted in with plaster, both where they join up to the door frames or brick walls, and where they butt against each other. Where a slab has to be cut it is advisable to form a groove by scooping a piece out.

Plaster slabs have been successfully used for external works fixed on wood framings and faced with tiles, but this is an expensive from of work, and if not carried out by experienced labor the tiles are liable to come off.

Seven years ago, 2-in. plaster slabs were used for internal and external walls of a school in Northumberland. The slabs were fixed to wood framing on outside, rendered over surface with cement, mortar floated to an even surface and rough cast with a mixture of slag and pea gravel, 1-in. internal slabs nailed to framing floated and skimmed with washed haired lime and putty, and finished with putty and plaster throughout, a dado of 3 ft. 6 in. being formed with portland cement back, and finished with Keene's cement face, trowelled smooth. It has proved a very satisfactory construction, as well as cheap.

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*From a paper read before the Concrete Institute, London.

A well known firm has recently introduced a plaster slab with a special face to receive cement rendering for external work, and they claim that it will withstand the weather for 20 years without being re-rendered. These have been used for external works on several jobs in the Midlands, and would appear to be eminently suitable for a cheap-system cottage or bungalow building. This system could be used in conjunction with light reinforced concrete piers and beams or wood framing, and has the advantage of being a very rapid construction. Doors and windows can practically be fixed in any position, as the openings can easily be cut, after the wall is up, without much danger of damaging other parts.

The foundation need only be 9 in. depth of good concrete under the wall, weathered on the outside, doing away with the necessity of any damp course.

The pumice slab is a very light form of construction, convenient to handle, and is manufactured from pumice and volcanic sand (imported from Italy) mixed with portland cement. These slabs form a rigid construction when up. Nails can readily be driven into them and take a good hold, doing away with the necessity of plugging for fixing skirtings or picture rails.

The hollow terra cotta partition tile is well known to many, and can be obtained in different sizes from several firms, and has the advantage of being easily handled. It can be obtained with a keyed or smooth face, and is being used just now extensively for exterior work. It is easily built up, the horizontal joints being bedded with cement, and the vertical joints grouted up, and seems to be quite effective in withstanding the weather, but it has only come into prominent use for this purpose recently, owing to the present shortage of other materials, and it remains to be proved what effect time will have on it. I am, however, strongly of the opinion that there are several points in its favor for this purpose, being cheaper than a brick wall of the same thickness, resists the damp better and insures a more even temperature, but does not lend itself to nailing. Where it is necessary to fix skirtings and rails, provision should be made for same at the time of erection by carefully inserting plugs in the joints. Should this not be done at the time of erection, and it is found necessary to fix electric fittings or hook rails, the joints should be cut out, and a plug built in, as any attempt to drive a nail into the tile is generally a failure, besides being liable to break the face of the whole tile.

Those of us who have had to do with partitions know only too well that they mostly have the annoying habit of showing cracks which more often than not go right through. These cracks may develop from either of the following causes:

The cracks generally occur just under the ceiling or near walls and door frames, or at top corners of door frames. The cracks at the tops or by the walls may be caused by variation of temperature, causing expansion or contraction, or through the supports deflecting or settling. Cracks also are generally to be found on top stories of buildings with large flat roofs, owing to the expansion of the flat as well as the partition, and up to the present I have not seen any successful method of stopping this occurring with a built-up partition, for even when cut and carefully filled in, the cracks will readily appear again.

The cracks on doors are particularly noticeable when the jambs project a few inches above the frame, and this is caused by the wood frame swelling, through absorbing the moisture from the partition whilst it is being erected. These can generally be stopped up successfully if cut out and filled in, after the partition has had time to dry out, and will not appear again, provided the door frames are fixed rigidly enough to prevent the partition from being shaken when the door is shut quickly. The best remedy, however, is to prevent this by stopping the door jambs off flush and carrying the partition over in one slab. This method is now recognized by most practical fixers as the best, and, with few exceptions, is carried out wherever possible.

The position of a partition is too often left to be settled after the floor and beams are all in, and then it is placed anywhere, whether the weight is supported by a main beam or only by the floor, away more often than not gets placed on the floor, away from the main beam, which may only be calculated to carry a load of 100 lb. per sq. ft., whereas many 3-in. partitions, when plastered both sides, weigh 18 lb. per square foot, and 10 ft. is quite an ordinary height for such a partition, therefore 1 ft. run would weigh 180 lb. The heaviest articles of furniture in domestic buildings are generally placed against the partition, and in an office it is quite an ordinary occurrence to find a heavy safe one side and a tier of shelves filled with books and papers on the other. Taking the total weight of the safe at 15 cwt. placed in the center of the bearing, and the bookcase at 2 cwt. per foot run, we find, if a 3-in. partition, 12 ft. wide by 10 ft. high, happens to be placed on the floor, we get the following load per square foot in that particular place:

| | |
|---|---|
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |

Therefore, 7,760 lb. divided by 36 equals 215.5 lb. per square foot on this particular portion of the floor, which is more than double what the floor weight and main beams were calculated to carry, and except for the large safety factor required by the authorities there would be more than mere cracks appearing. The writer is strongly of the opinion that the position of fall partitions wherever possible should be settled at the time of planning, and proper beams arranged to carry them, and when this cannot be done it is advisable wherever possible to have partitions cast in situ and reinforced with small steel rods, forming a beam from wall to wall. This method has been carried out by me and has always proved most satisfactory, and helps very considerably to tie the wall and distribute its load more evenly, and costs little more than a built-up partition.

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**Air Jet Hastens "Salting" of Wooden Ships.**—The "salting" of wooden ships at the shipyards of the Foundation Co. at Portland, Ore., is being facilitated by the use of an air jet. Salt is placed between the ceiling and planking of all wooden ships as a wood preservative. Ordinarily the process delays the planking. Under the method followed by the Foundation Co. a hole is bored through the ceiling and the salt blown into place by means of the air jet.

# Cost of Permanent Warehouses at Navy Yards and Stations

Permanent warehouses at navy yards and stations, having a total storage area of nearly 2,500,000 sq. ft., have been placed under contract since April, 1917, by the Bureau of Yards and Docks. In addition temporary facilities having an aggregate storage area of nearly 2,000,000 sq. ft. have been completed or are under construction. Information on the construction of these permanent structures is given by Civil Engineer Kirby Smith, U. S. Navy, in "Public Works of the Navy," from which the notes in this article are abstracted.

The plan for the warehouses were started on April 2, 1917, and as rapidly as possible proposals were invited and awards made.

The general features of design in all the structures are the reinforced concrete columns with a flat-slab floor system, and brick curtain walls with adequate glazed areas. Buildings are equipped with extensive toilet and locker facilities, sprinkler systems, fire walls, and a sufficient number of elevators, the larger structures having both freight and passenger service. The buildings are generously provided with loading platforms and large doors for handling incoming and outgoing stores.

The large warehouses at New York and Philadelphia were in use on Jan. 1, 1918. The New York building is the largest of its kind in the world. It is 11 stories high, 180 ft. wide, and 360 ft. long, without courts, and contains 712,000 sq. ft. of floor area. It was constructed in record time by the Turner Construction Co. of New York City. Contract was awarded April 21, 1917. Work on the site was started May 21, 1917, and the building completed Dec. 13, 1917. Three floors, however, were ready for occupancy on Sept. 8, 1917. Raymond concrete piles were used in the foundation. Three thousand seven hundred and seventy-six piles were used, averaging about 23 ft. in length, and were driven in 30 calendar days. The work was accomplished with four radial drivers working continuously.

Table I gives some of the general details of the permanent storehouses, and Table II shows the cost per cubic foot and per square foot.

TABLE I.—DETAILS OF GOVERNMENT STOREHOUSES.

| | | | * | | † | | | |
|---|---|---|---|---|---|---|---|---|
| Location. | Size. | Stories. | For soil, tons. | For piles, tons. | Rein. steel, tons. | Struc. steel, tons | Cement, est. Bbls. | Contract let. |
| New York | 180x360 | 11 | .... | 28 | 2,150 | 50 | 63,000 | 4-21-17 |
| Philadelphia¹ | ........ | 7 | .... | 20 | 842 | 20 | 27,300 | 5-23-17 |
| Boston² | ........ | 6 | 4 | .. | 800 | 20 | 27,300 | 6-16-17 |
| Mare Island | 64x404 | 5 | 6 | .. | 418 | 15 | 12,600 | 7- 6-17 |
| Charleston | 61x321 | 5 | .... | 20 | 384 | 12 | 10,000 | 9-17-17 |
| Puget Sound | 120x240 | 10 | 4 | .. | 1,275 | 20 | 21,000 | 8-23-17 |
| New London | 64x224 | 4 | 4 | .. | 171 | 11 | 4,000 | 8-22-17 |
| Hampton Roads | 118x494 | 6 | .... | 35 | 696 | 16 | 26,000 | 8-30-17 |
| Pearl Harbor | 61x150 | 4 | 3½ | .. | 120 | 8 | 2,600 | 9-29-17 |
| Newport | 61x241 | 4 | 1½ | .. | 172 | 5 | 4,000 | 11-10-17 |
| Washington | 100x250³ | 5 | .... | 20 | 590 | 12 | 12,200 | 11-16-17 |
| Brooklyn | 103x103 | 7 | 3½ | .. | 250 | 8 | 6,450 | 11- 3-17 |
| Mare Island | 60x186 | 4 | 5½ | .. | 106 | 5 | 3,306 | ....... |

¹L-shaped, 104½ ft. and 224½ ft. on ends; 304½ ft. and 200 ft. on sides. ²U-shaped. 184½ ft. x 264½ ft. with court 33½ ft. wide. ³And 50-ft. 1-story annex.

*Allow bearing on foundations. †Steel tonnage, estimated.

TABLE II.—COST OF GOVERNMENT STOREHOUSES.

| Location. | Cubic contents. Cu. ft. | Total floor area. Out to out of bldg. Sq. ft. | Floor area. Inside of walls. Sq. ft. | Actual cost, Per cu. ft. | Actual cost, Per sq. ft. |
|---|---|---|---|---|---|
| New York | 8,737,000 | 712,800 | 696,300 | $0.133 | $1.63 |
| Philadelphia | 3,604,300 | 307,900 | 300,300 | .141 | 1.65 |
| Boston | 2,996,100 | 251,700 | 243,200 | .173 | 2.04 |
| Mare Island | 1,338,400 | 128,700 | 125,600 | .148 | 1.54 |
| Charleston | 995,000 | 96,600 | 93,100 | .218 | 2.24 |
| Puget Sound | 2,976,700 | 287,800 | 280,600 | .170 | 1.76 |
| New London | 665,000 | 57,000 | 54,900 | .180 | 2.10 |
| Hampton Roads | 3,994,123 | 352,423 | 345,073 | .179 | 2.03 |
| Pearl Harbor | 416,000 | 37,000 | 35,300 | .232 | 2.61 |
| Newport | 731,474 | 59,409 | 56,985 | .202 | 2.49 |
| Washington | 1,981,250 | 137,500 | 133,900 | .190 | 2.74 |
| Brooklyn | 795,675 | 74,263 | 71,379 | .250 | 2.69 |
| Mare Island | 473,507 | 39,757 | 38,264 | .... | .... |

# Temperature of Steel and Colors Exposed to the Sun

A series of observations was made at Balboa Heights between April 19th and 27th to determine the maximum heating of steel exposed to the sun's rays in this climate. Blocks of steel 2-in. by 2-in. by 12-in. were exposed to the sun's rays in a manner favorable for maximum heating. These blocks were placed immediately over and lying on a concrete pavement, and were protected from the wind to reduce to a minimum the loss of heat by conduction and convection. The observations were made during the third decade of April, the season of maximum solar radiation in this latitude, as the midday sun is directly overhead about April 27th and its rays fall vertically on the earth.

A ½-in. hole was drilled into the center of each steel block. The resulting well was filled with mercury and temperature readings were made every 15 minutes by immersing the thermometer bulb into the mercury well.

The maximum steel temperature observed was 133° F. at 3:30 p. m., April 26. This reading is much higher than the maximum steel temperature observed at Culebra in March, 1914, due to a more favorable exposure of the steel in the present studies.

It would seem safe to assume, states the Panama Canal Record, that under the most favorable natural conditions possible the maximum temperature of steel exposed to the sun in this climate is not likely to exceed 135 or 140° F.

Similar records of exposed steel temperature made at stations in the United States and elsewhere are not available. It is thought, however, that the maximum temperature of exposed steel is higher in the Canal Zone than in the more humid sections of the United States, but lower than in the dry sections of the west and southwest, as humidity in the atmosphere absorbs a considerable percentage of the sun's rays, and diminishes the solar radiation reaching the earth's surface.

**Temperature of Colors.**—Experimental temperature observations were also made at Balboa Heights to determine roughly the comparative heat absorbing properties of various colors exposed to the sun's rays.

Two steel blocks 2 in. by 2 in. by 12 in. were exposed in similar manner. One of these blocks was painted black and the other was painted white. The black steel temperature varied from about 6° F. higher than the white steel temperature in the early morning, to approximately 20° higher in the middle of the day.

Similar results were obtained from two maximum solar thermometers exposed to the sun, the bulb of one covered with black bunting and the bulb of the other covered with white bunting, but the differences between the black and white bulb readings were not as great as the difference between the black and white steel temperatures.

Of the various colors black is known to absorb the maximum percentage of a solar radiation, and white absorbs the minimum per cent.

Other colors were experienced with also. The red bulb gave readings approximately half way between the white bulb and the black bulb, and a thermometer bulb covered with navy blue bunting gave approximately the same temperature readings as the black bulb.

The results obtained are thought to be only roughly comparable, as varying atmospheric and other conditions may affect the readings, such as wind movement, humidity, intensity of solor radiation; and the manner of placing the bunting cover on the thermometer bulbs.

It would seem that the maximum heating of corrugated iron roofing on dwelling houses in the Canal Zone might be reduced approximately 10° F. by painting these roof red instead of black, or reduced 20° F. by painting the roofs white.

## Wood in the Construction of Mill Buildings

The Forest Products Laboratories of Canada has frequently called attention to serious financial losses resulting from the ravages of so-called dry rot in mill and factory buildings of wooden construction. In a recent issue of The Canadian Engineer, Messrs. W. Kynoch and R. J. Blair, of the Laboratories, point out the causes and effects of the trouble and suggest precautions to be taken. The article in part follows:

Numerous cases in which dry rot trouble has occurred in Canadian buildings have been carefully investigated, and one of these which has been under observation for upwards of a year affords a typical example of a deplorable state of affairs which could have been entirely avoided had those concerned in the erection of the building been guided by the necessary knowledge of the technology of timber and the mechanism of the decay of wood.

From the point of view of the owners of the building, the facts are as follows: Five years ago a large factory building was constructed with heavy timber columns and beams and laminated floors of 2-in. x 6-in. planks, overlaid by $\frac{7}{8}$-in. hardwood. The timber was but partially seasoned when installed. The operations carried on in the building are such that the relative humidity in the interior is usually high. Serious decay was first noted about three years after the erection of the factory, and since that time has apparently become steadily worse. The tearing out of practically the whole of the timber construction has now become imperative, and the owners have decided to replace entirely with reinforced concrete at an estimated expenditure of $100,000.

**Causes of Decay of Wood.**—The decay of wood is due to the action upon it of low forms of plants, known as wood-destroying fungi and bacteria. For practical purposes the bacteria may be ignored. The germs of decay are not inherent in timber; infection must come from outside, and sound wood becomes infected in two ways, namely, by contact with either tissues or spores of a wood-destroying fungus under suitable conditions of temperature, moisture and air supply. It should be noted that this is not merely an interesting theory. It is a hard fact proved beyond dispute by extensive research and thousands of carefully conducted tests, and we can now induce decay in timber at will in the laboratory. A number of kinds of fungi which can be definitely identified are responsible for the destruction of timber in buildings.

In the particular case under discussion the range of temperature and relative humidity of the air in the factory were such as to provide exceedingly favorable conditions for the growth of several of the most destructive kinds. In addition, the unseasoned state of the timber facilitated decay because it was not even necessary for the wood to absorb water from the humid air before reaching the moisture content permitting the action of the destructive agent—the moisture was there already. Lastly, a large quantity of the timber used was of rapid growth and low density.

In mill or factory buildings, or parts of the same, where the operations carried on create very favorable conditions for the growth of fungi, the use of untreated timber, especially timber of low density, or timber containing much sapwood, is inviting disaster. If the timber be efficiently treated, however, there is no objection to the presence of a considerable proportion of sound sapwood or to the use of sound second quality or low density wood, provided that where necessary due allowance be made for the lower strength of the lighter material. The added cost of treatment could therefore in some cases be partially offset by using less costly timber.

It must not be inferred that treatment of timber for mill construction is always necessary. It is only requisite where the conditions are especially exacting. In other cases the use of timber of the proper quality and the observance of the following precautions will give reasonable assurance of immunity from decay:

**Precautions Against Decay.**—(1) Only dense material of the more durable species should be used, and the proportion of sapwood allowed should be small.

(2) The timber should be carefully inspected as to soundness, density and proportion of heartwood, and material not up to specifications should be rejected.

(3) Planking should be thoroughly seasoned in all cases. In large timbers the outer inch at least should be reasonably dry.

(4) Timber delivered on the work should be piled out of contact with the soil and with any unsound wood.

(5) All reasonable and practicable precautions should be taken to keep the wood as dry as possible before and during construction.

(6) Laminated floors should not be built while the wood is wet. If this is unavoidable, it is advisable to proceed as follows: As soon as the building is completed and the heating plant installed, close all doors and windows, raise the temperature inside the building to, say, 120° F. or as near this as possible, and maintain this condition for several days. If this can be done before building paper, pitch or hardwood flooring is applied over the laminated flooring, so much the better. (In the case of storage or other buildings not provided with heating plants, it is suggested that some temporary means of heating might be used. Where this is not feasible it would be safer to build with treated timber.)

(7) Wood should not be covered with plaster or other materials or painted until at least two years after the building has been occupied.

(8) Construction at joints, where beams enter walls, etc., should be such as to permit of ample ventilation.

(9) Special care should be taken in the construction of roofs when untreated timber is used. It is

necessary to have the interior roof planking thoroughly insulated so as to prevent condensation of moisture on it in winter.

(10) An examination of the planking and timbers should be made periodically, say, half-yearly, during the first three or four years after the completion of the building.

That timber frequently becomes infected in the lumber yard and that trouble from decay in mill buildings often arises from the installation of such infected timber is beyond question. Whenever infection occurs in the lumber yard it is usually due to the existence of conditions which foster the growth of fungi, such as the following:

(1) Location of yard in a damp, low-lying situation, or neglect to provide proper drainage.

(2) Allowing decaying waste wood to accumulate in the yard and to form centers for the distribution of infection.

(3) Using partially decayed foundation timbers for lumber piles, whereby disease is transmitted to sound lumber piled on same. (Foundation timbers should preferably be thoroughly impregnated with creosote oil.)

(4) Piling lumber too near the ground, thus retarding circulation of air where it is most needed and keeping timber in the lower part of the piles in a favorable condition for infection.

(5) Using diseased spaces in lumber piles.

(6) Permitting diseased timber to remain as part of permanent structures in the yard.

## Hair Mat Method for Remedying Faulty Acoustics in Office Buildings

Present day fireproof construction often tends toward faulty acoustics; the hard, flinty surfaces that form the walls and ceilings catch the sound waves and throw them back multiplied and magnified. A method of eliminating this trouble has been developed recently. This consists of the application of a scientifically constructed mat of woven hair to the ceiling and when necessary to other points. The millions of minute interstices of the mat absorb the sound waves in both direct and reflected action. The mat is covered in such a way to give the appearance of a pleasing and harmonious finished surface, without injuring the power of absorption. It in no way detracts from the architectural appearance or the decorative scheme. This method is known as the Wilson Echoliminator Treatment. The treatment is either installed by engineers of the Department of Insulation and Acoustics of Wilson & Co., Chicago, the points of faulty acoustics being discovered and treated to eliminate the echo, or the work can be done by the construction department of any firm.

## Building Industries Form National Federation

As the result of a conference of representatives of the building industries held last month at Atlantic City, N. J., under the auspices of the U. S. Chamber of Commerce, an organization—the National Federation of Building Industries, has been formed for the purpose of co-operating with the Government in carrying on the war, co-ordinating industrial activities and conserving resources. The Federation will be managed and its policies will be devised and carried out by a body of delegates to be known as the Building Industries War Service Committee. The articles of association provide that—

Any association of building material manufacturers or dealers, or of contractors engaged in building, or of architects or engineers, or any association of other persons, firms or corporations related to building, may become a member of the Federation and be represented in the War Service Committee upon the following conditions:

(a) Members may be either national associations or regional associations.

(b) A regional association is an association composed of members whose places of business are located or whose products are distributed at large over the United States.

(c) A regional association is an association composed of members whose places of business are located and whose products are distributed principally in a single city, district or region.

Each national association will have three representatives and each regional association one representative on the War Service Committee. This committee will hold its first meeting Nov. 4.

## Personals

William N. Thatcher has resigned as county engineer of Harris county, Texas.

James Carruthers has resigned from the presidency of the Halifax Shipyards Company.

C. Stewart Lee has resigned as assistant manager of the Pusey & Jones Co., shipbuilders.

C. S. Giles has resigned as city engineer of Crookston, Minn., to accept a similar position at Grand Forks.

C. O. Yoakum has resigned as general manager of the Beaumont Shipbuilding & Dry Dock Co., of Beaumont, Tex.

Joseph Fargill, of New York, has been appointed general manager of the Lone Star Shipbuilding Co., of Beaumont, Tex.

Lyman Spitzer, secretary of the Spitzer Building Co., Toledo, O., has been commissioned a captain in the Quartermaster's Corps.

Prof. C. S. Brown, of the University of Tennessee, has been appointed State Fuel Engineer with offices in the Capitol, Nashville, Tenn.

T. Albeus Adams, of Montclair, N. J., has been appointed a member of the New Jersey Hudson River Bridge and Tunnel Commission, succeeding Thomas N. McCarter.

Jeff D. Bartlett, a business man of Amarillo, Tex., has been appointed city manager of that city, succeeding A. W. Armstrong, who resigned recently to engage in other activities.

C. L. Ingleneld, formerly properly connected with the Federal engineers, has acecpted a position with the construction department of the Pittsburgh, Pa., board of education.

Harry J. Johnson, of Philadelphia, Pa., has been appointed housing and general manager of the new shipyard village below Gloucester City, N. J., where 550 homes are being built.

Finn Hannevig, brother of the president of the Pusey & Jones Company, Christoffer Hannevig, has been appointed vice president and general manager, with entire charge of the Wilmington, Del., shipyard.

Arthur C. Downs, assistant to Henry C. Allen, city engineer of Syracuse, N. Y., has accepted a position with the housing department of the Bureau of Labor, with headquarters at Bethlehem, Pa.

John J. Maloney, superintendent of construction with F. W. Cunningham & Sons, of Portland, Me., has been commissioned as a first lieutenant and assigned to duty with the U. S. Quartermaster's Corps.

Prof. L. A. Hartley, who has been a member of the faculty of the University of Kansas, has asked for leave of absence for the duration of the war in order that he may go to Philadelphia where he will take a position under the shipping board.

A. R. Nottingham has resigned his position with Purdue University after 5 years' service to accept a position at the North Dakota Agricultural and Mechanical College at Fargo. He will have charge of the Government work in the engineering department.

Robert S. Hague, a superintending engineer of the marine department of the Standard Oil Company, has been called by the Emergency Fleet Corporation and will have supervision of the work of speeding up the production of steel ships in Pacific Coast yards.

At the recent annual meeting of the Empire Engineering Co., Inc., Contractors-Engineers, New York, the following officers and directors were elected: President and chairman, J. H. McClement; vice president and general manager, J. Rulon Miller, Jr.; vice president, Beverly R. Value; secretary, treasurer and comptroller, C. A. Nicklas. The directors are J. H McClement, Alfred Skitt, Franklin Nevins, Beverly R. Value, J. Rulon Miller, Jr., and C. A. Nicklas.

## Industrial Notes

The Chicago Pneumatic Tool Co. announces the appointment of C. W. Cross as special representative for the sale of pneumatic tools to railroads, vice L. C. Sprague, promoted to be district manager of sales for the company at New York.

E. I. du Pont de Nemours & Co., of Wilmington, Del., has equipped a large office building solely for the use of its Advertising Division. The Du Pont American Industries and the advertising managers of the individual companies are: The Arlington Works, A. R. Kneale; Du Pont & Harrison Chemical Works, L. B. Steele; Du Pont Fabrikoid Co., A. H. Berwald; Du Pont Dye Works, S. F. Withe; Harrison & Bridgeport Paint Works, J. Coleman Bentley; Industrial Explosives, E. F. Carley; Agricultural Explosives, F. W. Wilson; Sporting Powders, Edmund Doremus. The Canadian Advertising of the Arlington Company, Ltd., and the Du Pont Fabrikoid Company, Ltd., both of Canada, is in charge of J. M. Cane.

*Road and Street*
*Monthly Issue*

# ENGINEERING AND CONTRACTING

HALBERT P. GILLETTE, *President and Editor.* LEWIS S. LOUER, *Vice President and General Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering field. See advertising page for further information and subscription coupon.

**Roads and Streets—1st Wednesday**
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies

**Waterworks and Hydraulics—2nd Wednesday**
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power

**Railways and Govt. Works—3rd Wednesday**
(a) Excavation and Dredging (c) [illegible]
(b) Levees and Canals (d) Railway Construction

**Buildings and Structures—4th Wednesday**
(a) Buildings (c) [illegible]
(b) Bridges (d) Miscellaneous Structures

Volume L. CHICAGO, ILL., SEPTEMBER 4, 1918. Number 10.

## A Suggested Form of Road Contract Based on Efficiency and "Speed Factor"

Mr. S. E. Fitch, an engineer in the highway department of New York state, recently suggested an interesting plan for making road contracting safe and profitable for efficient contractors, while at the same time securing speed and low cost for the public. He calls attention to a fact that has grown all too familiar to most of us, namely, that "Low bidding has forced the more able contractor out of the road business, and has sent the less able one into bankruptcy." Therefore he concludes that the present method of "letting state road contracts to the lowest bidder who can furnish bonds has serious fundamental defects." Agreed. His proposed solution of this economic problem is somewhat like certain solutions previously offered in that it would secure to the contractor as his fee a "percentage of the savings under any estimated cost which he might effect." The more novel parts of his solution are two: First, each contractor to bid a unit profit on each class of units. Second, each total profit plus bid to be multiplied by the contractor's "speed factor" established on his last road job.

The "speed factor" would be determined by dividing the actual construction time by an estimated "standard time" for that job. A "standard cost" would also be estimated, and the contractor's bid profit or fee would be increased by a percentage of the saving effected below the "standard cost." It is contended that in this way competition would operate in awarding contracts, and, at the same time, the recorded "speed factors" would serve to eliminate contractors who are not capable of handling work rapidly.

The "unit profit" bid on each class of work (say, 5 ct. per cubic yard on earthwork) would cover the contractor's profit for his own services and that of his "organization," and would not include a return for the use of equipment. A schedule of rental prices for the use of each kind and size of equipment would be specified in the contract.

"The speed factor and the sliding scale of profit would act as an automatic governor to maintain the proper relation between the time of construction and the cost of the work."

Plans of this sort merit the careful consideration of highway engineers, for it is clear to most experienced road builders that the old form of competitive unit price bidding is doomed to extinction. There are two serious objections to the cost-plus-a-fee contract as hitherto generally used: First, in that it permits favoritism in the award of contracts, and is therefore open to suspicion where public works are involved. Second, in that it removes the main incentive to do the work as economically as possible.

## A Society of Draftsmen Joins the American Federation of Labor

A good many civil engineers have felt, for some time, that many draftsmen would eventually join a labor union unless they were able otherwise to secure what they regard as being adequate salaries. Such a step has at last been taken by about 1,000 draftsmen in Government employ. The Washington Society of Draftsmen has been formed and has become affiliated with the American Federation of Labor, as Union No. 16137. We predict that this movement will spread, much as it may be deprecated by most engineers who are not draftsmen.

Commenting on this matter in our issue of Aug. 21, Mr. O. W. Childs said:

> [illegible]

While Mr. Childs makes too sweeping a generalization, it is a fact that engineers have hitherto done relatively little toward securing adequate salaries for engineers and draftsmen. In fact a great many engineers in high positions have done all they could to keep down the salaries of their subordinates. For example, the chief engineer of a great public works job actually bragged that he had kept the engineering expense down to 3 per cent of the total cost of the job. In accomplishing this end he had paid the minimum salaries that young engineers seeking experience were willing to accept. Was this an honorable thing to do? Was it likely to prove economic for the public in the long run? Was it a very exceptional act? We think not. Shortsightedness and selfishness are much too frequent even among engineers in high positions.

If engineers in high positions are "only human," and therefore not always humane, engineers in low positions can scarcely be blamed if they, too, prove "only human," even if in doing so they also prove shortsighted.

Tired of waiting for adequate salaries, a thousand draftsmen, many of whom are graduate engineers, have joined a labor union. For those engineers who expect to remain draftsmen perhaps it was a wise move to become members of the American Federation of Labor, but we doubt the wisdom of such a step even for them. For men who hope to aid in establishing civil engineers as leaders and managers of public affairs, it would be a serious mistake to join any labor union that uses the strike as a weapon to secure its demands. Now, as never before, engineering societies are fraternizing largely for the purpose of educating the public to recognition of the real worth of engineering. Surely it is better thus to work toward adequate remuneration by creating a larger demand for and a wiser appraisal of engineers, than to attempt to force the public to pay larger salaries to members of this profession.

## The Universal Enforcement of the "Skip-Stop" Plan by the Fuel Administration Is a Great Object Lesson in Economics

Is it eventually to become one of the functions of our Federal Government to force individuals and corporations to use economic methods and machines? The question is no longer academic, for the exigencies of war have already led to Government action of this sort. The latest and most startling of these acts is the enforcement of the "skip-stop" plan of operating street cars, a plan that was fully described in our issue of Aug. 21.

The Federal Fuel Administration has ordered all street railway companies to put into effect the "skip-stop" system on all lines by the end of September. Careful estimates and experience with the plan of not stopping street cars at every corner have led to the conclusion that 10 per cent of the coal used by street car companies, or 1,600,000 tons annually, can thus be saved. This plan has been in successful operation for seven years in Kansas City, for six years in Cleveland, and for shorter lengths of time in more than a dozen other cities. But if left to the ordinary course of economic progress another seven years would elapse before the "skip-stop" plan would be in use in a quarter of our cities. Why? Simply mental inertia and the opposition of local politicians.

The average city councilman is keen not to offend even a small minority of the voters, for he realizes that voters that are offended are militant, whereas voters that are pleased are usually inert. Now it always displeases a small minority—usually about one in four—of those who ride in street cars to be compelled to walk an extra block in a round trip "to town." What matters it to the one short-distance rider if three other longer distance riders favor the "skip-stop" plan because it reduces their traveling time 20 per cent? This is but one of many instances of the rule of a militant and selfish minority, made possible by our "representative system" of city government. But suddenly a new phenomenon appears. A branch of the Federal administration, caring nothing for militant minorities but caring a great deal about winning the war, is brought by electric railway engineers to see that a vast tonnage of coal can be saved by the "skip-stop" plan. Whereupon an order is issued to every street railway to adopt this plan within a month.

Conceive, if you can, what could be accomplished in America in the way of increased productivity and economy if our Federal Government had the authority to make every individual and every company adopt any method or device that had been proved to be economic. No engineer acquainted with the application of the principles of the science of management can doubt that if the universal adoption of those principles could be forced upon producers in general, this nation could increase its productivity fully 25 per cent. That would alone add more than twelve billion dollars annually to the national income. But that is not all. The application of the principles of the science of management is only a fraction of the total enginery at our disposal. We have literally countless labor and material saving machines and appliances that are scarcely used, although many of them are generations old. Does this sound incredible? Certainly not to any engineer who has a wide acquaintance with the literature of engineering.

Take so simple a thing as the heat insulator for steam pipes and boilers. It has been known to engineers for nearly a century that by encasing boilers and pipes with magnesia or other suitable insulators, practically all heat radiation and conduction losses could be stopped. Furthermore, it has been known to engineers that the saving in fuel thus effected would pay an annual interest of 20 per cent on the cost of the heat insulator. But go into the basements of steam-heated residences if you want to get a conception of how rarely this knowledge is applied. The landlord may know that heat insulators would earn a big return on their cost, but since they would earn it for the tenant and not for himself, he does not cover the boiler and pipes adequately if at all. The tenant, even if he knows the economics of heat insulating, will not spend the money for insulators whose use he may not enjoy for more than a year or two before he moves out. For similar reasons very few houses have double windows, although double windows will save fully 15 per cent of the fuel required to heat the average house. On these matters the fuel administration has power to act, and it should act.

In our issue of March 27 we published directions for house heating prepared by the Engineering Group of the Denver Civic and Commercial Association. The engineers estimated that by following those directions fully 20 per cent of the fuel commonly used in heating buildings can be saved. Of the 600,000,000 tons of coal annually produced, about one-sixth is used in households and other buildings. Hence if one-fifth of this 100,000,000 tons can be saved, it would amount to 20,000,000 tons annually. Experienced mechanical engineers estimate that of the 500,000,000 tons used for steam power purposes, fully 10 per cent can be readily saved by utilizing methods that have been well known to engineers for 20 years. In short, by the universal application of long known methods of fuel saving it would be possible to save fully 70,000,000 tons of coal every year, and this with a comparatively slight outlay of capital for new apparatus, etc.

The fuel administration, by ordering the universal adoption of the "skip-stop" plan has given the nation an object lesson in economics that will be very beneficial. Let the administration now extend the same general plan to every user of fuel, and make it compulsory to apply well established engineering knowledge in effecting fuel economy. By making us save more than $300,000,000 worth of fuel each year, we may come to realize that it pays to have Federal bodies with authority to put into universal effect every economic measure that engineers and inventors have demonstrated to be sound.

## How the Government Wastes Paper

All publishers are now required to use extreme measures in an effort to reduce the consumption of paper—all but the various branches of Government. Editors of daily papers, as well as of class periodicals, are recipients of more "publicity matter" than ever from the Federal Government. Very, very little of it is regarded by its recipients as being worth reprinting even in brief abstract. It would seem that about three-fourths of the paper thus sent out could be saved, simply by having each broad class of periodicals at Washington represented by a competent editor. Thus if a trained technical editor were to pass on all matter that it was proposed by the different Government departments to send to the engineering periodicals, it is safe to say that one-third the present amount of Government publicity matter would suffice. A recent chat with the editor of a daily paper has led the writer to conclude that a similar editing in Washington would eliminate about 80 per cent of the printed matter now being sent to daily papers.

The excessive use of the franking privilege by Congressmen has long been a scandal, but there have been few comments on the broadest distribution of reprints of speeches from the Congressional Record. Rarely is one of those speeches read by a recipient of it, and still more rarely is it worth reading by any one. Now that the clamp of necessity is being used to squeeze down the size of daily papers, it would seem at least no more than equitable to apply the same squeezing machinery to the printed speeches of our legislators.

## Engineers Should Study Art of Advertising

It would be well if many an engineer were to spend fully a year in the publicity department of a large company or with an advertising agency. It would be well for such engineers personally, and it would be well for the engineering profession. Relatively few engineers appreciate the educational power of publicity. Still fewer know how to apply that power efficiently. But if engineering is to become the dominant profession in public as well as in private affairs, it will require publicity on a large scale. Not only the voting public in general but the heads of many business enterprises lack an adequate conception of what engineering is and what it can accomplish.

Would it not be wise for every engineer at least to read one book on advertising and subscribe for a magazine on advertising? Would it not be wise for many city and county engineers to write proposal advertisements? We think so.

## The Salaries of Municipal Engineers in Chicago Have Been Stationary for Twenty Years

In another column we have commented upon the action of 1,000 draftsmen who have joined a labor union. Many engineers are apt to take a similar step before long, unless engineering societies bestir themselves. John Ericson, City Engineer of Chicago, recently said:

> [illegible]

This is a condition that is not confined to Chicago. Indeed it is typical. What are engineering societies doing to change such conditions?

## How to Drive Respiratory Diseases From the Cantonments

Respiratory diseases have caused nearly all the sickness and deaths in American army cantonments. Typhoid, which created such disaster during the Spanish war, is almost unknown in our army camps. It is said that respiratory diseases could be similarly reduced if the soldiers and the general public would stop spitting and coughing promiscuously. But the publicity campaign by which it is aimed to bring this about is not likely to succeed for many years, if ever. On the other hand, there is a means that can be applied with assurance of success. Every cantonment should be provided with a smooth, hard pavement that should be flushed thoroughly with water twice daily. Wash the germ-laden dust into the sewers, and require every soldier to flush his nose and throat twice a day with an antiseptic. If that is done there will be a speedy relief from the serious inroads of pneumonia, "colds," etc.

## The Hazards of the Road Contracting Business in New York State

"Three quarters of the contractors engaged on New York state road work during the past few years (and there have been more than 200) have ceased to be active. Most of these are known to have been in financial difficulties." This statement was made by a New York engineer and contractor last fall who attributed this condition to the hazards of the business. These hazards, he claims, have become unbearable, largely because the form of contract has placed the entire burden of uncertainty upon the contractor. As an example he cites the rejection of stone from a quarry that had been marked on the plans as being acceptable, resulting in an increased cost of $15,000 on that one item.

In an article a New York State Highway Engineer attributed much of the recent misfortune of contractors to low bidding by inexperienced firms. He added that large profits were made by the early contractors for state roadwork, and that the knowledge of this had attracted hordes of profit-seekers. In this he was mistaken. The editor completed the first New York state road contract about 18 years ago, and considered himself lucky in "breaking even." He knew personally scores of other New York state contractors who had the same experience, or worse, during the following 10 years. In short, the history of state road contracting in New York for 18 years has been one of almost universal disaster. But so little publicity has been given to the fact that each year has yielded its "new crop of fools" who have tried to "beat the game." It can't be done under the present form of contract in New York state, and we doubt whether it can be done in any state where inexperienced men are given contracts and where the contractor is required to assume all the risks.

## Experiences with Street Flushing at Worcester, Mass.

To the Editor: In your issue of Aug. 7, I notice an article headed, "A Street Ought to Be Built Like a Hospital Floor," which treats with the matter of flushing city streets.

As Street Commissioner of the city of Worcester, Mass., up to the middle of May of this current year it was my good fortune to install the first system of trolley car flushing with swinging arm which had been installed in any city in the United States. This flusher was able to wash and flush with ease our widest streets, which are mostly composed of cement grouted granite block, many of them from 10 to 20 years of age. These trolley car flushers, with the addition of motor truck flushers on side streets not covered by street railway tracks, were operated over every street in the city carrying any type of pavement whose nature was in any way permanent. In other words, we flushed granite block, grouted or sand joint, asphalt, wood block, brick, topeka and cement concrete pavements with bituminous blanket surfaces.

This system has been in operation for over 3 years and no particularly injurious effects have been noted in the case of any of these pavements. In fact, with the butuminous surfaces it is much better to have them flushed and washed once a day than to be continually sprinkling them through the day time, allowing the water to lay on the surfaces, instead of being flushed off by pressure, and collecting in depressions and rotting the material. The streets are flushed daily, at night when the traffic is clear, and are ready in the morning, clean and bright as a newly scrubbed kitchen floor.

The best results are obtained from the cement grouted granite block pavements. Some doubt has been expressed in regard to sand joint granite block paving standing up under flushing, but after an experience of 3 years or more flushing this type of pavement every night during the season, from April to October, I can state positively that no injurious results occur; that the pavement is made much cleaner than it could be made in any other way, and the work is being continued day after day without injury to the pavement.

Boston, Mass. A. T. Rhodes.

## Causes of Unrest Among Draftsmen

To the Editor: Since a draftsmen's union has been organized as stated in your issue of Aug. 21 the following letter which I wrote on July 15, 1918, to the U. S. Department of Labor may be of interest to you:

> I have carefully studied the definitions of "engineer" and "draftsman" which you recently submitted to me. I regret to say that I fail to find anything very definite about them.
>
> Just why engineers persist in trying to separate draftsmen and engineers is more than I can see. If, as F. H. Newell says, an engineer "is primarily a man of ingenuity," then a draftsman is an engineer pure and simple, for is he not responsible for most all the ingenuity displayed in engineering? Then why not call him an engineer? The term draftsman is not one which conveys any mark of respect; rather it is decidedly the opposite, and draftsmen object to it.
>
> My plea is for a profession in which all are engineers precisely the same as the medical profession in which all are doctors. It is only the narrow minded and falsely educated engineers who insist on the sub-divisions, sub-titles and segregation in societies which prevents a united profession. I would refer these men to the Standard Dictionary, which gives as one definition for "engineer," "one who runs an engine." I can assure you that if the self-styled engineers continue to exclude the so-called draftsman from the engineering profession that there will be draftsmen's unions formed and the field is now over-ripe for this development.
>
> My suggestion is: First, that the use of the words draftsman and drafting room be entirely eliminated, so far as possible, and that engineer and engineering department be substituted. Second, that engineer indicates a member of the engineering profession (a profession being an occupation that involves a liberal education and mental rather than manual labor).

Whether the union was organized or not is not so much to the point as the cause of existing conditions and unrest among draftsmen. Draftsmen have been the victims of a great many crimes which may be generally summed up as office mismanagement and a feeling, which amounts almost to contempt, held towards them by other engineers not now "on the board."

Actual and comparative low salaries is the surface cause for resorting to the union. Naturally, draftsmen who are receiving $5 to $7 per day feel discontented when coal miners receive $6 to $20 and steel rollers as much as $40 per day. The line of least resistance is to swallow the bait of a walking delegate and join a union. That is, without intelligently arguing the principles involved and actuated by greed for more money regardless of worth, they play a dollar on the union and gamble on squeezing ten from their employer—for the present a safe gamble. The reckoning must come later. Germany convinced herself that the world could be ruled by force instead of reason, but the world has refused to be either so convinced or ruled. All union men should note this fact.

Do not mistake my attitude toward the unions. The good they do is evident, but if any of their methods are wrong they should be exposed and fought. It is well known that the American Federation of Labor desires power—great power. It is also well known that draftsmen, though few in numbers, possess great power, when organized. In fact draftsmen could prevent the turning of almost every wheel in industry. Be it understood that there is no distinction between designers and draftsmen. Is it any wonder then that the Federation wants the draftsmen? But the deluded draftsmen, who might possess their power entirely independent of the unions, throw it all into the arms of labor, becoming subservient to them and subject to strike call in support of some hod-carriers' demands. Draftsmen as a class, are better educated than mechanics and it is hard to see just how a gain in salary can offset the loss in position effected when the intelligent are at the mercy of the lesser intelligent. A college education has been wasted on a man who thinks that his happiness can be found solely in accumulating the almighty dollar.

Referring to the above letter it will be seen that I do not blame the draftsman for existing conditions as much as the "self-styled" engineer. He is presumed to be older, more experienced, more intelligent and broader minded and should claim the draftsman as his own, rather than try to separate him in a different class. Right here let me say a word to these engineers. German engineers have gone through this question of organization and they have their employes' society which amounts to a union. I am acquainted with several Germans in this country, who know not the meaning of democracy, and wish to preserve their class distinction here. This is subtle proof to me that American engineers are once again allowing themselves to be influenced by the German idea.

However, I do believe that draftsmen are entitled to receive higher pay, particularly for the best men. Further, I think the latter are worth at least 100 per cent more than they are getting. They are worth it for this reason: in order to qualify for a position of "experienced draftsman" they must have, as a rule, the equivalent of a college education and about 6 years' experience. In other words, a man must go through many years' training to fit himself ror his work. The work is so responsible, so highly exacting, that he is a nervous wreck by forty and must take up some other work. These are points to consider when talking of draftsmen's salaries.

There is just one way to forestall the spread of unionism among draftsmen and that is to grant them healthy increases. If it is not done voluntarily, it will be forced by the unions anyway. The next thing which must follow quickly is the introduction of scientific management and an increase in the caliber of the average chief draftsman.

R. W. Shelmire,
Secretary, Chicago Chapter, American Association of Engineers.
Chicago, Ill.

## Suggestion for Study of Street-Cleaning Methods

To the Editor: In your issue of Aug. 7th, we notice a commendable article: "Some of the Things the Engineering Council May Accomplish," printed on page 138.

Point No. 15, "Ditto as to street flushing," would seem to suggest to the Engineering Council that the public should be educated as to the economic advantages of street flushing to the exclusion of any other method of cleaning streets. This is palpably as undesirable as to suggest that they should be educated to the Elgin method to the exclusion of all other methods.

We know of cities that report the cost of cleaning by the Elgin method at a lower figure than flushing.

Would it not be better, and fairer, to suggest to the Engineering Council that they educate the public to the idea of having streets cleaned thoroughly, efficiently, and in the most economical manner? As a supplement to this, the Engineering Council could, if it cared to, undertake investigations to indicate the costs of various methods of cleaning streets. And if time permitted, the Engineering Council could proceed to secure data as to the efficiency of the various methods, the quality of cleaning actually obtained, the effect on the pavements if any, the desirability of various systems in connection with motor truck hauling, the value of street cleaning by the various methods to the health of the community, etc., etc.

Geo C. Dodge,
New York, N. Y. Elgin Sales Co.

## Profit or Loss Sharing Agreement in Contracts of Virginia State Highway Commission

A profit or loss sharing agreement for payments for work done by contractors is being employed by the State Highway Commission of Virginia. This is practically the same as the South Dakota State Highway Department contract, discussed in the Aug. 21 issue of Engineering and Contracting, and is along the lines of the Massachusetts plan, described in our July 3 issue. The Virginia form follows. The agreement is being used at present only on a small scale for bridge work in connection with the commission's regular form of contract.

[illegible]

1. [illegible] as determined by such prices and quantities will be herein referred to as Contractor's Estimate.

2. The contractor shall be paid actual cost for labor and [illegible] under this contract, whether the cost be more or less than the Contractor's Estimate. The cost of work thus determined will herein be referred to as the Labor and Material Cost

3. [illegible] Contractor's Estimate for his actual supervision of the work the use, repair and upkeep of all equipment, and all office and other expenses, commonly known as "overhead expenses," except that should the Labor and Material Cost be less than the Contractor's Estimate, the contractor's fee will be increased by the amount of one-half the difference, or should the Labor and Material Cost be greater than the Contractor's Estimate the contractor's fee will be reduced by the amount of one-half the difference.

4. Should it become necessary to increase or diminish the quantities of work or material shown on the proposal the Contractor's Estimate shall be revised, accordingly, at the unit prices given. The Contractor's Estimate as changed shall be known as the Revised Contractor's Estimate, and shall be compared with the Labor and Material Cost in computing differences, instead of the Contractor's Estimate as first determined.

5. The prices to be paid the contractor for labor, teams, materials and other items, of every kind and description, furnished by him, shall be subject to the approval of [illegible]

6. The contractor shall furnish bills and pay[illegible] the seller and by the contractor. Payrolls shall be [illegible] the payee and certified to by the contractor

[illegible] description shall be shown on the bills and shall accrue to the [illegible]

[illegible] statements of amounts due, with certified copies of payrolls and [illegible]

## Door Mats Used for Oiling Road Roller Wheels

Ordinary cocoanut fiber door mats are employed by the William Horrabin Co., Sioux City, Ia., paving contractors, in oiling the rolls of their 3-wheel type of rollers. The mat is wired to the scraper arms on each side of the roll, and the oil is applied through a horizontal piece of perforated pipe which is connected to a tank fastened in the top of the cab. The amount of oil is controlled by valves in the piping.

# Policy of U. S. Highways Council Regarding Highway and Street Work During the War

The United States Highways Council on Aug. 23, made public its regulations, effective Sept. 10, governing highway and street work during the period of the war. The announcement in part follows:

1. All proposed highway, street, culvert and bridge construction, reconstruction and maintenance involving: (a) the issuance of bonds; (b) the use of rail or water transportation; (c) the use of coal or oil as fuel; or, (d) the use of cement, brick, asphalt, oil, tar, crushed stone, or steel, (also sand and gravel where shortage exists) as highway material, should first be submitted for approval to the United States Highways Council through the appropriate State Highway Department. Forms have been prepared for this purpose and a supply placed with each State Highway Department. No manufacturer will furnish any road building material until the project has been approved by the United States Highways Council.

2. The Council again urges that new highway and street construction be confined to the most essential needs. If this is done there will be a far greater probability that the work thus selected can be promptly and effectively carried through to completion than if an amount far in excess of the available facilities were to be undertaken.

The Council in passing upon the projects which come before it will give first consideration to maintenance with a view to conserving all the highways already completed if possible.

Reconstruction will be favorably considered by the Council only where it is clearly established that maintenance is no longer possible except at prohibitive cost.

New construction will be given consideration by the Council in the following relative order of importance:

(1) Highways and streets of military value;

(2) Highways and streets of national economic value;

(3) Unfinished contracts involving contractural obligations (incurred prior to April 5, 1918, where bond issue is involved) which may not be disturbed without serious consequences;

(4) Streets and highways which although not of national economic importance are of such extreme local importance or the construction of which has progressed to such a point as to cause serious hardship if their construction or completion is postponed.

The Council is hopeful that the selective consideration of new highway and street construction by the township, county and municipal officials and in turn by the State Highway Departments will so materially eliminate the less essential projects as to make it possible for the Council to render active aid on the projects it approves. The aid contemplated will be in the form of such action by the other government agencies involved as will remove obstacles to the speedy completion of the projects.

3. By way of definition of highways of military and national economic value, the Council offers the following:

(a) A highway of military value is one used regularly for the transportation of military supplies in considerable quantity; for the movement as an established practice of army truck trains, or which is essential to the efficient operation of a military cantonment, post, or plant.

(b) A highway of national economic value is one which serves or will serve, if properly improved, directly to promote the welfare of the nation and not merely the local welfare. As examples it may be stated that in this class would be placed (1) highways which although not directly used for military purposes yet serve to help win the war by greatly facilitating the output or movement of war munitions and supplies; (2) highways which can clearly be shown to relieve congestion on railroad lines in a territory which is actually in need of such relief; (3) highways which give access to or promote the output of natural products needed by the nation to a marked degree; (4) highways which further housing operations undertaken by the Federal Government or by other agencies with the approval of the Federal Government would justify at times this designation.

4. State Highway Departments are requested to give most careful consideration to each application on its merits in the light of the policy announced by the Council and to exercise the power of disapproval freely. Only the projects approved by the State Highway Department will be considered by the Council unless the department itself is in doubt and wishes a decision in the nature of a precedent.

5. The Council will shortly begin, in co-operation with the Office of Public Roads of the Department of Agriculture, and the State Highway Departments of the several states, the preparation of a program of road and street construction, reconstruction and maintenance throughout the United States for the working season of 1919. The purpose of the program is to obtain an approximation of the character and amount of street and highway work deemed essential in 1919, together with an approximation of the amount and character of financing required, the amount and character of the various materials entering into the work, the extent to which rail and water transportation will be involved, and the probable demands upon the labor supply. The preparation of the program in each state will be directed by the State Highway Department, and will cover all state, county, township and municipal highway and street work.

# Cost of Street Oiling and Street Sprinkling at St. Paul

Dust prevention measures at St. Paul, Minn., in 1917 involved the water sprinkling of 237 miles of street and the oiling of 83 miles. The latter method, according to the last annual report of M. N. Goss, Commissioner of Public Works, produced the best results. The cost of two oilings during the past season was the same on a 32 ft. roadway as the cost of water sprinkling four trips per day during the entire season. It is the intention of the department to increase the oiling of streets as rapidly as they can be put into a condition to take oil and reduce the amount of water sprinkling, provided, of course, that the price of oil does not go beyond an economical point.

The department had 107 water tanks, 96 being continuously in use during the warm weather.

A Kinney auto oiler of 1,000 gal. capacity was purchased by the department and put in service June 21st. The old equipment, consisting of two Studebaker automatic pressure distributors, one Studebaker tank attachment and one Hvass-Pilsbury pressure distributor, each of 600 gal. capacity, also were used the latter part of the season.

Property is assessed for water sprinkling on the basis of the number of trips per day and the number of months and fraction of a month the street is sprinkled. 38 rates were used in spreading the water assessment. The great number of rates was due largely to water sprinkling of streets in the spring for various lengths of time before they were oiled.

The rate per front foot for two round trip sprinklings a day for the entire season was 7 ct. or $3.50 for 50 ft. lot.

Property is assessed for oiling on a basis of the number of times a street is oiled and the width oiled. The rate per front foot for two oilings for a 27 ft. width was 6 ct. or $3 for a 50-ft. lot.

The auto oiler distributed 189,642 gal. of oil at a cost of $1,309.64. This cost covers the chauffeur, operator, gasoline, oil and up-keep, and reduces to $6.91 per 1000 gal. distributed. The horse drawn oilers distributed 252,105 gal. of oil at a cost of $2,138.56. This cost covers team hire and up-keep of the wagons and reduces to $8.48 per 1,000 gal. distributed.

**Five Mechanics Keep 25-Truck Fleet in Good Condition.**—The Knutsen Motor Trucking Co. of Cleveland, O., operating 25 trucks, of which 10 or more are continually used on the 40-mile haul between Cleveland and Akron, employs five mechanics to keep the fleet in good mechanical condition. One of these men is an expert capable of supervising all kinds of truck repair work, while the other four men are less skilled. The expert and three of the men work at the Cleveland repair shop and warehouse during the day. The other man is kept on duty at night to fix any emergency troubles that might arise, as the company operates a night service between Cleveland and Akron during the summer.

# Mechanical Material Handling System Reduces Labor and Hauling Costs and Eliminates Waste in Construction of Michigan Road

The use of a complete mechanical system for handling material, by means of which the waste is unusually low, hauling on the grade is unnecessary, handling costs are lowered and the number of men required is considerably reduced, is the outstanding feature of the construction of 3½ miles of road in Macomb County, Michigan. The job is near Mt. Clemens, on what is known as the Shore Road, about 18 miles from Detroit. An 18-ft. roadway is being built with a 5-in. concrete base covered with a 2-in. layer of asphalt.

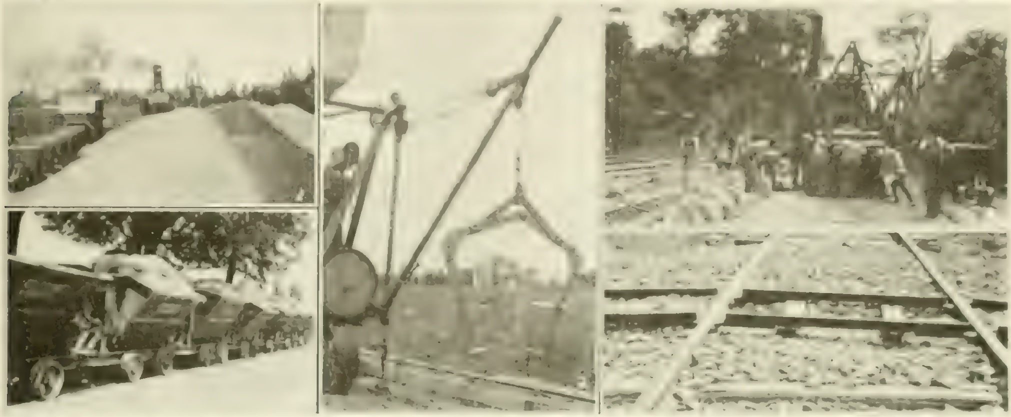
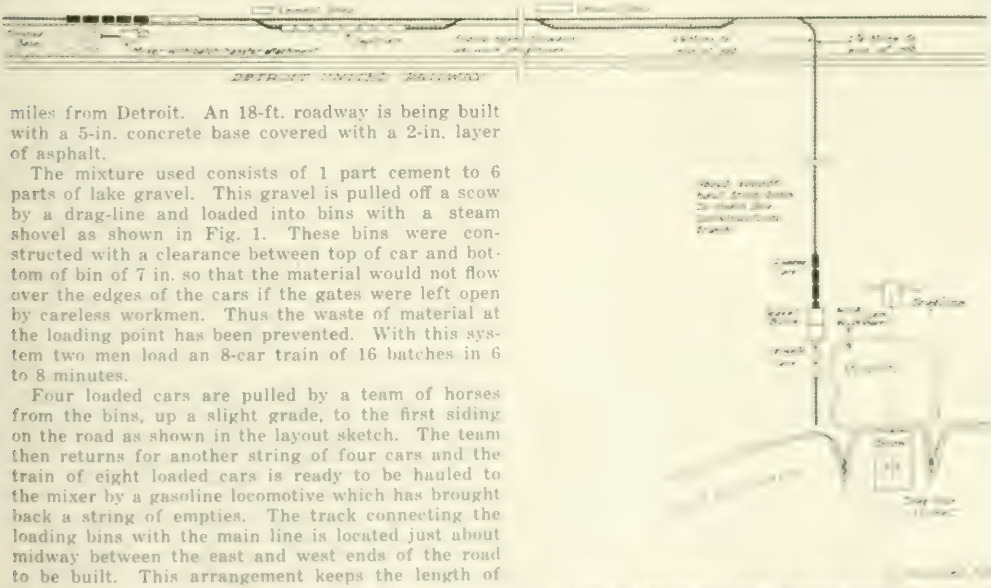


Fig. 1—Sand Brought by Dragline to Shovel and Loaded Into Bins. Fig. 2—Batch Transfer Attachment Fitted with Bail to Lift Boxes From the Cars. Fig. 3—Only Five Workmen Needed at Charging End of Mixer. Fig. 4—Cement Hauled in Cars From Storage Sheds to Mixer. Fig. 5—Rigid Crossing Makes Derailments Almost Impossible.

The mixture used consists of 1 part cement to 6 parts of lake gravel. This gravel is pulled off a scow by a drag-line and loaded into bins with a steam shovel as shown in Fig. 1. These bins were constructed with a clearance between top of car and bottom of bin of 7 in. so that the material would not flow over the edges of the cars if the gates were left open by careless workmen. Thus the waste of material at the loading point has been prevented. With this system two men load an 8-car train of 16 batches in 6 to 8 minutes.

Four loaded cars are pulled by a team of horses from the bins, up a slight grade, to the first siding on the road as shown in the layout sketch. The team then returns for another string of four cars and the train of eight loaded cars is ready to be hauled to the mixer by a gasoline locomotive which has brought back a string of empties. The track connecting the loading bins with the main line is located just about midway between the east and west ends of the road to be built. This arrangement keeps the length of haul at a minimum for all parts of the job.



Layout of Shore Road Job, Macomb County, Michigan

Each car carries two boxes each holding 20 cu. ft. of lake gravel. The mixer is fitted with the Lakewood batch transfer attachment from which a bail is hung as shown in Fig. 2. This bail is so balanced that it will stay open, thus permitting a train to move under it without the necessity for swinging the derrick. By means of this apparatus a box of gravel is lifted from the car and dumped into the loading hopper. Three bags of cement are then added and the batch is ready to be mixed. With this arrangement only five men are needed at the loading end of the mixer—three to discharge a box full of gravel into the hopper and two to handle cement. This is shown in Fig 3, which also shows the grade free from piles of material due to the methods employed. Also, observing the actions of the men and judging from several pictures taken after a batch was loaded, the men seem to come to rest each time in about the same positions. This would indicate that their work had become almost automatic and, therefore, more efficient. Four men are needed at the discharge end of the mixer.

Work was started at the west end of the job. Cement was stored in several sheds along the road. It was hauled from the sheds to the mixer in cars, as shown in Fig. 4. Each car holds 60 bags of cement.

As the road parallels the tracks of the Detroit United Ry. a method of crossing these tracks with the narrow gauge track was devised as shown in Fig. 5. Plates were bent at right angles, bolted to the bottom of the light rail and to the web of the heavy rail so that the top of the light rail would be held 1¼ in. above the top of the heavy rail. The 20-lb. rail was cut to make a 5-in. gap where the heavy rail had to be crossed. With this arrangement the flange of the 12-in. wheels on the small cars just touches the top of the heavy rail and the chances of derailment are almost eliminated. In fact, no derailment has occurred at this crossing to date.

The work is being completed at the rate of about 400 ft. a day. The best day's work is 512 ft. of finished concrete base.

The layout of the job is indicated by the sketch. As the work progresses the siding nearest the mixer is moved forward about ¼ mile. The moving of these switches is a comparatively easy job as the track is built in 15-ft. sections, and can be quickly taken part, moved, and assembled.

The advantages of this method of handling material are, briefly: A large capacity plant can be used on very narrow roads; there is no loss of material; materials are kept clean because no aggregates come in contact with the ground; proportioning the mix is made simple by the uniform amount of aggregate transported by each car; work is not delayed by bad weather as muddy subgrades do not interfere with handling the aggregates.

The contractor is Thomas E. Currie, Detroit. The track, switches, cars, mixer and mixer attachments were supplied by the Lakewood Engineering Co., Cleveland, and the plant layout was suggested by that company's engineering department. An Erie shovel is used to handle the sand and a Plymouth gasoline locomotive hauls the cars. The concrete work was started about July 18 and at the time this article was written a little more than 1½ miles of concrete had been laid.

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## Small Pile Driver for Putting Down Fence Posts

Posts for the 17-mile board fence at the American Lake (Washington) cantonment were put down at the rate of about 180 per 8-hour day by means of a small pile driver mounted on a 2-horse truck. The posts were pointed, were 5 in. to 10 in. in diameter, and 9 ft. long, of which 3 ft. was below ground. They were spaced 8 ft. apart. The pile driver had a 4-HP. Fairbanks gasoline engine operating a small drum by means of a friction clutch. The crew consisted of an engineman, a teamster and two men handling posts. The actual driving time per post was 60 to 90 seconds. The hammer weighed 600 lb. and had a 6-ft. drop when beginning driving.

## Direct Method of Handling Concrete Aggregates with Trucks

A very satisfactory method of handling material is being employed by the Harrison Engineering & Construction Co., Buffalo, N. Y., on its 22-mile concrete road contract in McDowell County, West Virginia. The plan is described in Concrete Highway Magazine as follows:

The contractor is operating fleets of five 2-ton trucks. The bodies of these trucks are equipped with an end dumping device, and lately have been equipped with three lateral partitions, making four separate compartments, each containing one 2-bag batch of 1:2:4 mixture. Aggregates are received from a railroad which parallels the highway under construction. Sidings are available so the haul to the mixer is seldom more than 1½ miles, and constantly lessening as the mixer approaches. At these sidings an unloader in used to handle the stone which is received in hopper cars. The unloader consists of an electrically operated bucket elevator from a pit under the rails to a storage bin having a capacity of 15 yd. The bin is installed at a height sufficient to allow a truck to run along side and receive its charge of stone. The stone is measured on the truck by a stripe painted along the body.

The sand is discharged from the cars in stock piles from which it is shoveled by hand into a small compartment car, having four hinged measuring boxes at a height convenient to discharge into the four compartments of the truck. The car operates on a narrow gage track, which is easily moved as the pile changes its shape.

The cement storage is also at the siding and when operations were first started, two bags of cement were placed in each compartment after the stone and sand had been deposited. This proved unsatisfactory, however, as the wind would blow the cement away and it also sifted from one compartment to the other. The contractors are now using a truck, and three men, including the truck operator, to haul and place the cement at the mixer.

This method of handling the aggregates saves labor. The records show an average saving in time of 30 minutes to every mile trip. The stone from the car to the mixer drum is handled by one man in the car to keep stone to the hopper, one mechanic to look after the motor and conveyor, two men to operate the bin gates and level the stone in the trucks. The sand is shoveled into the measuring boxes by four laborers and the instant the truck comes along side the boxes are tripped by these men.

When the truck arrives near the mixer it is turned and backed to the mixer hopper. There the truck body is elevated and each of the four batches are deposited in the hopper. In this operation, a boy mounts the truck body and unfastens the partitions as the batches are needed. Two men from the grading gang step back to see that none of the material spills on the grade. If this does happen they place it in the hopper and give the engineer the signal.

The advantages of this method are: A measured batch of aggregate, no waste of material on the subgrade, no foreign material in the stone and a very little in the sand, fresh cement from the storehouse, and the saving in labor of eight shovelers and four wheelers on the stone and two wheelers on the sand.

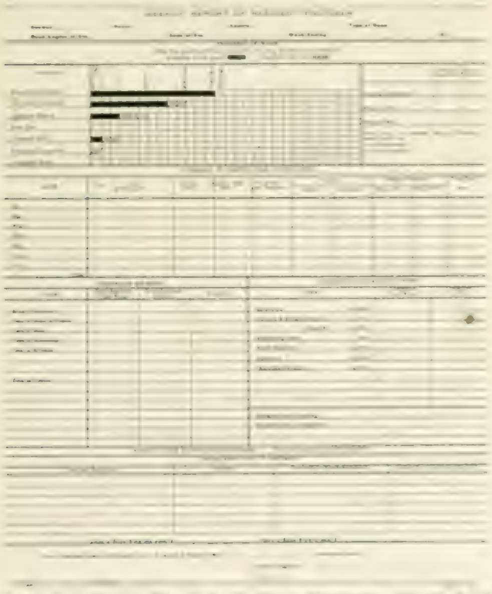
# A Weekly Report for Resident Engineers on State Aid Road Work

By C. M. HATHAWAY,

Assistant Road Engineer, Illinois State Division of Highways.

The Illinois State Aid Road Law passed in 1913 provides that all state aid work shall be let by contract to the lowest responsible bidder. It further provides that the making of plans and estimates for such work and the handling of all construction incident thereto shall be under the jurisdiction of the State Division of Highways.

The state aid funds are allotted to the 102 counties (with one exception) in proportion to the county road and bridge tax of each, and, subject to approval of the State Department of Public Works and Buildings, each county may select the location of the roads for improvement and the type of construction. The result is sections of work scattered not only among the several counties, but often in three or four remote sections of a county.



Form for Weekly Report of Resident Engineers, Illinois State Division of Highways. Actual Size of Form 8½ x 11 In.

From July 1, 1914, to Dec. 31, 1917, there had been put under contract over 500 sections of state aid road and bridge work.

In order to handle the engineering work in the most efficient and economical manner, the state has been subdivided along territorial lines into seven districts, each under a district engineer, who, with a local force of engineers, handles all engineering and construction work in his district. Taking into consideration the fact that the radius of the average engineering district is 50 to 60 miles, and that there may be in progress in a district 15 to 25 sections of work entirely remote from each other, it is readily apparent that the district engineer must have some form of report by which the several resident engineers and inspectors may keep him thoroughly familiar with the progress of the work at all times.

To design a form complete enough has proved easier than to design one simple enough not to be a source of confusion. The result of too many details is neglect and carelessness in reporting the more important features, and careful discrimination and study has been necessary to work out the desired result.

After taking into consideration with the district engineers the features most essential for a weekly summary of the work, the form shown was evolved recently. While a majority of the items are readily apparent upon inspection, a few may need explanation to bring out their particular value.

The items "per cent completed" and "rate of progress" under "progress of work" give a concise statement of the condition of the three main construction features. Each week this information is used by the District Engineer in making up a general report for the main office showing the progress of all work.

The "summary of cement used during week" is very complete and is deemed essential on concrete road work in order that a careful check may be kept on the amount of cement used daily. The value of this feature has always been strongly emphasized by each District Engineer.

The "summary of completed work" affords information upon which the District Engineer may base his monthly estimates.

As all contracts are let on a unit price basis, it frequently happens that extras not provided for in the contract are encountered. The notation of these extras gives the District Engineer a chance to allow them on monthly estimates. It also enables him to keep a check on the amount of money spent and the amount available for extras.

It will be noted that provision is made to end the report Friday night instead of Saturday. This enables reports to reach district headquarters Saturday or Sunday, thus permitting the "District Engineer's weekly report" to the main office to be sent in by Monday of each week.

## Organization and Output of Brick Paving Gang in Vermilion County Roads

In the construction of the monolithic brick pavement for the Vermilion County, Illinois, Bond Issue Roads, the average gang consisted of 32 men distributed as follows:

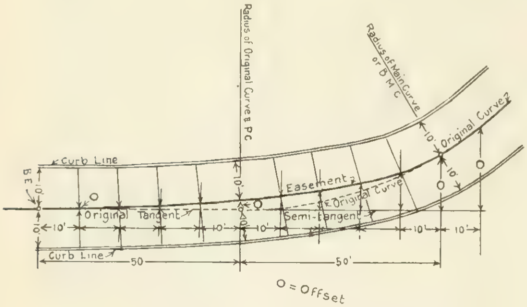
[illegible]

[illegible] ment was laid per day. The pavement is 10 ft. wide and consists of a 4-in. wire-cut-lug paving brick laid directly on a fresh concrete base 4 in. thick at the side and crowned 1 in.

**Meeting of Southern Appalachian Good Roads Association.**—The Southern Appalachian Good Roads Association will meet in Asheville, N. C., Nov. 19, 20 and 21. A. D. Williams, Chairman State Road Commission of West Virginia, Morgantown, W. Va., is President of the Association.

## Superelevations and Offsets for Curves for Paved Highways

The tables and diagrams reproduced below were developed in the office of Samuel J. Humes, Engineer of King County, Washington, the idea being to work out a method of super-elevation and of easing of approaches to highway curves that would at once be simple for use by field men and would also give satisfactory results in the completed paving. The tables and diagrams have been employed for some time in the construction of King County pavements and have proved very satisfactory.

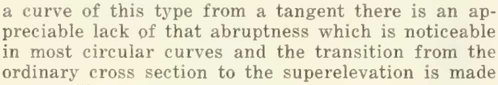


Sketch Showing Method of Offsets on 100-Ft. Easement.

The tables, it will be noted, are prepared for pavements 20 ft. in width. However, the superelevation table, by means of simple proportion, can be used for any other width desired. The superelevations are based upon the empirical formula—

H = 0.05D, in which H is the total elevation in feet of a 20-ft. road, and D equals the degree of curve.

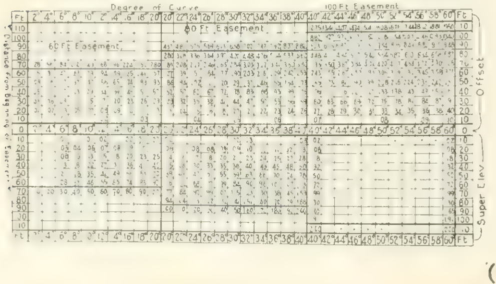
The easement, while not upon a true spiral, permits ready adjustment of the curve to the simple circular curve upon which the lines of the original surveys have generally been made. Upon approaching a curve of this type from a tangent there is an appreciable lack of that abruptness which is noticeable in most circular curves and the transition from the ordinary cross section to the superelevation is made very easily. In rounding these curves in cars there is not the tendency to swing out across the road as is the case with the majority of curves not provided with superelevations and easement. This, of course, is a very valuable feature, especially where the view is somewhat obstructed by embankments at the side of the curve and reduces the necessity for widening curves, at least, in those of long radius.


Uniform surface where h is greater than twice height of Crown
See Note
Slope 2' in 10'
Crown Surface
℄ Profile Grade
h = Super Elevation = h/2 (.05 D)

NOTE:-Where h is less than twice height of Crown, Super Elevation is applied to outside half of Pavement only

Sketch Showing Method of Superelevation on Curve on 20-Ft. Paving.

Table of Offsets and Superelevations.


Degree of Curve
100 Ft Easement
80 Ft Easement
60 Ft Easement
Distance from beginning of easement
Offset
Super Elev
Ft

## Suggestions for Road Patrolmen

The following reminders for patrolmen are taken from a bulletin prepared by J. T. Donaghey, Maintenance Engineer of the Wisconsin Highway Commission:

You must answer all questions in a good natured way, no matter how foolish they may appear.

Assist the traveling public if in trouble without charge. The majority of them will appreciate the kindness and no doubt repay it sometime.

If the other fellow loses his temper, be sure to control yours. You will then have a decided advantage.

Do not leave machinery, tools or loads of material within the limits of the traveled way when not in use.

Pile the stone or gravel used for maintenance at a convenient place outside the ditch line.

Do not leave a ridge of earth, sod or loose stone in the center of the road after dragging.

Do not use the road drag when the surface is hard and dry.

Do not use the road planer on clay soil when the surface is wet and sticky.

Use the road drag just before the road enters the winter season, and again as the frost is leaving the ground in the spring.

The last work in the fall and the first work in the spring should consist of cleaning the inlets and outlets of all culverts and drain tile.

Be familiar with the automobile laws and rules of the road. Report violations to the proper officials. Report owners of cars not displaying proper number plates to the Secretary of State at Madison.

The road you are proud of will cost but little more effort on your part than the road you must apologize for. Remember it is doing the little things that seem hardly worth while that will make the difference between an excellent road and just an ordinary road.

Remember, there is always something that can be done if you arrange your work properly.

You must know this bulletin by heart.

**Convict Labor on Road Work in Missouri.**—The scarcity of teams and local labor for road construction has increased the demand for prison labor throughout Missouri. The State Highway Department has had good success with convict labor, but has been unable to obtain groups of men for several projects because all available prisoners are at work in the industries operated at the State Prison. The best results from prison labor have been obtained where the men were organized into groups, specific work laid out, and proper equipment supplied.

**City Managers' Convention to Be Held Nov. 6.**—The 5th convention of the City Managers' Association will be held at Roanoke, Va., Nov. 6, 7 and 8. Virginia is the birthplace of the city manager plan and 1918 is the 10th anniversary. Of the 124 manager cities one-third are within 300 miles of Roanoke and more than two-thirds within 600 miles. War activities of cities under the manager plan will dominate the program. H. G. Otis, City Manager of Auburn, Me., is Secretary of the Association.

# Notes on Highway Design

By J. L. HARRISON.

**Preliminary Investigations.**—When a new system of highways, or even a short stretch of new road is to be laid out, there is apt to be more or less of a choice of routes. The first step toward the construction of the desired highways should, therefore, be the determination of the comparative merits and demerits of these routes, in order that an intelligent selection may be made. This preliminary investigation should include a field examination of the salient physical features of each route, but, while these should always be influential in guiding the final selection, it must be admitted that the social and political advantages of the various routes will frequently outweigh all other considerations. It therefore transpires that these matters must be carefully considered before matters of a purely technical nature are taken up, not only because much of the cost of minute preliminary investigations can, in this way, be avoided but also because it will usually be found that more progress can be made by conforming to the general public desire as to the location of a given highway than by working in opposition to such desire.

**Population Benefited.**—Social and political demands rest essentially on the question as to who shall obtain the direct and obvious benefits which will be derived from the contemplated construction. These benefits include increased land value for the abutting land owners, increased business opportunities for merchants so located that their businesses will be stimulated by whatever change there is in the flow of traffic, and increased ease of travel and better opportunities for recreation as well as minor benefits too numerous to mention for those members of the community who are in a position to avail themselves of them. Such benefits are very well understood by the layman and he will overlook no opportunity to secure whatever of them he can. Moreover, these benefits are of such value that where they are permitted by law to fall to property owners and business men who are required to render no return for them, local contests are apt to develop in which even important engineering considerations are quite overlooked.

The broader aspect of developing local business centers also plays a large part in the selection of highway routes. The dominant town in a county and the dominant city or cities of a state are prone to use their influence to locate highway improvements so that they will stimulate the growth of the social and the business life of these centers even if this must be done at the expense of the smaller communities.

Theoretically, the highway engineer's selection of highway routes should always be based on his judgment as to the best interest of the whole community, but practically he will find that the dominant influences at work in the community in which he resides limit his selection much more closely than this, for public leaders quite generally hold that the location of a road is a matter for public determination rather than for technical judgment and that an engineer is employed to solve the difficulties of putting a highway where the public has been influenced to want it placed rather than where it ought to go. It is to be hoped that this condition of affairs may eventually be changed, but while it persists engineers must recognize it and perform their work accordingly.

**Volume of Traffic.**—In the days of horse vehicles, the volume of traffic which any route would develop was an important consideration in judging the merit of competing routes, and it has been customary to point out that the intensity of the agricultural, mining, and commercial development along the proposed routes is the dominant feature in creating traffic and that ruling grades, distance and, in some cases, curvature, are the dominant influences in effecting the proportion of the possible traffic which can ultimately be developed. Aesthetic considerations have also been mentioned as affecting the volume of pleasure traffic.

Of recent years the development of automobile and motor truck traffic has, however, greatly modified the formerly accepted relation of these matters to the selection of routes. Thus, whereas the highways of the past have generally been built to facilitate the commercial life of rural regions, modern highways, though no less effective in this respect, are used so much more for recreation than for business that the commercial traffic which competing routes will develop is ordinarily of no particular importance, the difference in the commercial traffic obtainable on the various routes actually representing only a small per cent of the traffic which will use any of the routes if improved.

**Grades.**—The matters of grade has also ceased to hold its original significance because motor vehicles are so geared that they will climb any reasonable grade with ease. Thus, where roads are constructed for motor traffic, grades of from 10 to 12 per cent are not particularly objectionable, though they offer something of a problem to drivers who must use them during winter weather. During the days of horse-drawn traffic it was usually assumed that a 5 per cent grade ought to be the maximum grade and tables were carefully prepared to show what effect any particular grade had on team efficiency, etc., but all of this has now been rendered of little or no value because team traffic constitutes so negligible a percentage of the traffic on the highly improved roads in most sections of the country and because, even in those regions where it is still the dominant traffic it is rapidly losing its importance. For horse-drawn traffic, the rule was frequently laid down that the steepness of a grade and its length ought to be so adjusted that a team can pull over the grade what it could pull all day on the level. This theory, of course, assumed short periods of heavy strain on the team and varied the allowable grade according to its length. The rule was a good one, but is now obsolete, for it imposes grades which are too low and too expensive to be justifiable in view of the proportion of horse-drawn vehicles now using the highways.

With motor vehicles, except trucks drawing trailers, the problem is not a serious one for such vehicles are so built that with a full load and a given engine speed the only important difference between driving on a level road and driving on, say, a 12 per cent grade is one of speed, and even in this respect the difference is more apparent than real, for as between a mile at 12 per cent, 2 miles at 6 per cent or 3 miles at 4 per cent the average driver will prefer the steep grade and will make it in quicker time than he will make the lighter grade. There is, therefore, no very good reason for lengthening distance to reduce grades when motor vehicles are being provided for, unless it is assumed that the road will be used by trucks with trailers in tow, and there is, of course, a strong reason for keeping the grade as steep as possible because of the indisputable fact that where grades are necessary it is almost always cheaper to build a mile of road on a steep grade than it is to make the same point by building 2 or 3 miles of road with easier grades.

At present only a few of the more advanced highway engineers have accepted this view of the matter to the extent of authorizing the use of steep grades on roads which will carry little or nothing but motor traffic. As a matter of fact, however, this is largely due to the fact that there is just enough horse-drawn traffic developed along improved routes so that a good deal of public criticism can be worked up if the convenience of this traffic is ignored. Hence many engineers have adopted a compromise grade which is based on the theory that the maximum grade ought to be such as to require a good pleasure automobile to drop out of its direct drive. As a working basis for a compromise between the needs of horse-drawn traffic and the hill-climbing possibilities of motor cars, this is quite satisfactory for it recognizes the fact that many cars are not built so well that they can work indefinitely on steep grades without developing mechanical troubles due principally to overheating the power plant, and that horse-drawn traffic should receive reasonable consideration.

The one objection to this as a standard is that the ability of different makes of automobiles to climb long distances on their direct drive is very different, depending, as it does, on the number of cylinders in the engine, on the general efficiency of the driving mechanism, on the ratio in the differential, as well as on minor matters too numerous to mention. As a result there can be no definite compliance with this standard and so, as might be expected, maximum grades of from 6 to 8 per cent are adopted as conforming to this requirement. As the best makes of automobiles can climb for considerable distances on even steeper grades than this, an 8 per cent grade is justified under this assumption, but it will be found in practice that where grades are over a mile long, comparatively few cars in the hands of ordinary drivers can be depended on to climb more than a 6 per cent grade on direct drive.

**Distance**—Sometimes grade and distance are closely related but it frequently happens that distance is an entirely independent feature. In the days when the dominant traffic was horse-drawn, distance was an important consideration and as between two competing routes the shorter one was apt to be given careful consideration merely because it was the shorter. Now, however, with the development of motor vehicles distance assumes a position of much less importance. This is, of course, because the larger part of the traffic on improved roads is recreation or semi-recreation traffic, and the man who is traveling for the pleasure he can derive from so doing finds few things of less importance than the length of the route between two given points.

On the other hand, distance has a direct effect on the cost and in this way may have a distinct bearing on the advisability of any route. However, it should be borne in mind that cost is not itself a factor in the selection of routes, though it is all too often so referred to. It is, rather, a measure of the tangible factors and as such becomes the expression of the summation of the influence of these tangible factors. It is true that this summation may exceed the funds available, and that this may force a readjustment of the factors but, even in this case, the influential factors are those underlying the cost.

**Curvature.**—High curvature was never much of an argument against the selection of a route to be used by horse-drawn vehicles. The slow movement of such vehicles made collisions infrequent and losses due to collisions a negligible matter. Curves had, of course, to be built so that wagons hauled by four or, in some cases, six horses could pass on the curves, but even under this requirement very short curves could be used.

The advent of motor traffic has changed this. The rate at which vehicles move has been doubled and redoubled and the weight of these vehicles has been so increased that collisions are highly dangerous to life and limb, as well as destructive of property. This danger of collision can only be avoided by maintaining a long range of vision. The most desirable length of such a range of vision depends on the distance required in order to shift the direction of travel enough to avoid collision. This, in turn, depends on the rate at which a car is moving, the skill of its driver and even on his ability to think quickly. As a result, no exact minimum view ahead can be set, but a view of 300 ft. has been found, in practice, to be generally satisfactory and should, therefore, be preserved at all points along the highway and if a proposed route cannot provide such a range of view this should be considered as militating most actively against its adoption.

Even where the view is clear the necessity for the use of short curves should be considered as a strong argument against a proposed route. There is no use in denying that many drivers are reckless and that the only way to avoid accidents on sharp curves is to avoid the use of sharp curves. If a route is only feasible in case sharp curves are used this should be deemed a serious argument against it.

## Engineering Cost of County Road and Bridge Work

The total expenditure for road and bridge work in Iowa in 1917, according to County Engineers' reports, was $15,165,476, an increase of $828,420 over the amount for the previous year. Of the total, $7,466,797 was for bridges, $3,588,338 for county roads and $4,140,340 for township roads. The total expenditures for the three previous years were: 1916, $14,337,056; 1915, $13,525,617; 1914, $11,601,000. The percentage of engineering cost for the four years, according to the Service Bulletin of the Iowa Highway Commission, was as follows:

| | Per cent | | | |
|---|---|---|---|---|
| | 1914. | 1915. | 1916. | 1917. |
| County engineering | 2.85 | 2.75 | 2.53 | 2.58 |
| Highway commission | .64 | .60 | .63 | .59 |
| Total all engineering | 3.49 | 3.35 | 3.10 | 3.17 |

## Cost of Street Oiling in Hamilton, Ont.

During the season of 1917, 803,390 sq. yd. of streets of Hamilton, Ont., were oiled and covered with screenings. The average cost of the work, according to the last annual report of E. R. Gray, City Engineer, was as follows:

| | Per sq. yd. |
|---|---|
| Labor oiling | $0.00056 |
| Oil, 0.1421 gal. at 9.6 ct. | .01394 |
| Total oiling | $0.01450 |
| Labor spreading screenings | 0.00125 |
| Screenings, 2.4 lb. at 85 ct. per ton | .00098 |
| Total screening | $0.00223 |
| Grand total, oiling and screening | $0.01673 |

The cost of teams per hour was 75 ct. and the cost of labor was 35 ct.

# The Work of Highways Transport Committee in Developing Effective Use of Roads

The work of the Highways Transport Committee, Council of National Defense, this committee having been appointed to make the most effective use possible of the highways as one of the means of strengthening the nation's transportation resources, is now being developed in such a way as to take in every state in the Union. Further, through the medium of state highways transport bodies, functioning with the national body, this organization is being developed in some states not only down to the districts, but to the counties and even communities.

The state highways transport bodies are a part of the State Council of Defense. They consist of the following: The chairman of the State Highways Transport Committee, five members of the highways transport body, and a secretary. The five members in question are named to represent areas of varying sizes and populations, each of the five members being chosen from one of such five different areas, and in turn serving as chairman of his district committee. The district boundaries are laid out in harmony with existing conditions, the aim being that the most effective results possible may be brought about. For instance, in one locality, large population centers may be found to be best as the heart of one or more districts. Again, in other sections, where cities of large population are not found, the district boundaries may be made to embrace agriculture, lumber, oil, or other areas.

Such highways transport committees have been organized in practically all of the states of the Union, and are now functioning not only as a part of the State Council of Defense, but with the national body at Washington. While in some states the work in detail has gone forward to a most gratifying extent, thus pointing the way to those in which the state highways transport body has been more recently organized, without exception efforts looking to the desired end in all states are being made.

The main activities of the national and its allied highways transport bodies are for the present being devoted directly to the following:

Return loads bureaus, rural express, co-operation with Federal Railroad Administration, transport operating efficiency.

These activities may be briefly interpreted as follows:

Return Load Bureaus: Elimination of empty running of trucks by the bringing together of shipper and truck owner in a systematic way, so as to provide a full load wherever possible.

Rural Motor Express: Rapid development of the use of the motor truck in regular daily service over a fixed route with a definite schedule of stops and charges; gathering farm produce, milk, live stock, eggs, etc., and on the return trip carrying merchandise, machinery, supplies, etc., for farmers and others along the route.

Co-operation with Federal Railroad Administration: Taking of congestion from crowded rails on to the open highways and also freeing terminals from railroad and express congestion.

Transport Operating Efficiency: The making of transportation more efficient, which end will be sought through encouragement of such use of highways transport as will operate to avoid the making of trips with only part loads; also, briefly, the elimination of waste efforts, man power, and time in loading and unloading.

Typical of the work being done by some of the state highways transport bodies, that already inaugurated in such representative states as Connecticut, New York, Pennsylvania, Michigan, Illinois and Colorado may be suggested. For instance, resolutions recently adopted at a meeting of the Michigan Highways Transport Committee point the way to the manner in which that state is aiding in this vital phase of the war work.

Resolutions, in part, recommend that inter-city and rural motor express and return loads bureaus be established where practicable in every part of the state; that steps be taken to have the state constitution amended and suitable legislation enacted to aid in the granting of franchises, properly restricted, for organizing and equipping motor express lines.

Again, in Pennsylvania, an organization down to the county has been perfected, and noteworthy development has been brought in such counties as Allegheny, Butler, Clinton, Lawrence, Luzerne, McKean and Tioga. Pennsylvania co-operated most effectively during the heavy snows of the past winter to the end that routes selected for Government motor truck trains on their way from points north to seaboard were cleared of snow and the overland trips, the first attempted by the Government, made possible. In this work Michigan also lent a hand most effectively.

In Illinois the transport division, Highways Transport Committee, has worked out a compact plan of organization and drawn up a method of procedure.

It has established a return loads bureau in Chicago, located at the headquarters of the State Council of Defense, and preliminary steps have been taken looking to the establishment of subsidiary bureaus in some of the larger towns between which and Chicago there is considerable movement of freight.

Connecticut was the first state to organize completely, with a return loads central bureau at Hartford. It has numerous flourishing bureaus outside of Hartford, equipped with telephone service, that delays in the transmission of orders may be eliminated. The Hartford bureau is constantly on the alert to the end that interested persons such as truck owners, merchants, farmers, manufacturers, may know just when and where return loads service is available.

A gratifying number of inter-city motor express routes are now in operation in Colorado, and within a short time these will be organized as rural motor express routes in harmony with the plans of the national highways transport body. The establishment of return loads bureaus throughout Colorado also is being given intensive study, and the state highways transport body is confident of being able shortly to have this vital war activity in operation.

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**Chicago Meeting of Am. Assoc. State Highway Officials.**—The meeting of the American Association of State Highway Officials to be held in Chicago has been changed from Oct. 7, 8 and 9 to Dec. 3, 4, 5 and 6. A. D. Williams, Chairman State Road Commission of West Virginia, Morgantown, W. Va., is Acting Secretary of the Association.

# Method of Obtaining Pavement Contour Without Strikeboard

A method of securing the contour of pavements without the use of strike boards, which is entirely successful for all classes of road and street construction when the pavement is 20 or more feet wide, is described in the August issue of the Concrete Highway's Magazine, to which we are indebted for the matter that follows:

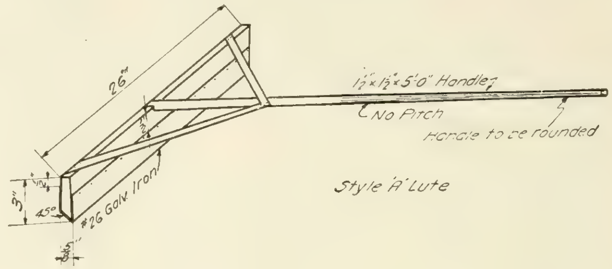
The method is frequently referred to as the "luting method" because a lute which resembles a toothless rake, is used in place of the strikeboard to manipulate the concrete to proper contour. The final contour of the pavement must be designated by points that will allow a workman operating a lute to place the concrete to approximately the required finished section. To establish these points, eight steel pins of the type shown in an accompanying drawing are used. They are made so that when the pin is in place, 2 in. of it will show above the work in order that the pin may be located and removed after luting is completed. One pin should be placed at the center line and one at each quarter point. For wide streets one is placed at the center line and others at intervals of from 4 to 6 ft. across the entire width of the pavement. The rows of pine are placed longitudinally every 8 to 9 ft. apart.

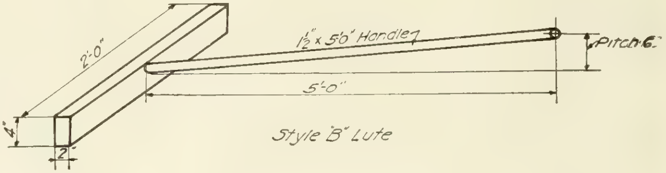
Pins are set by the use of sighting sticks or T's. The top of the lug is used as the grade point. On especially wide work it is necessary to figure the ordinates for certain distances and to compute the sighting or setting stick notches accordingly from one side to the center.

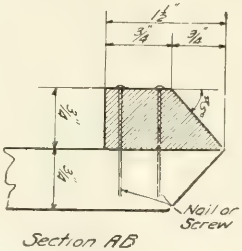
The shortest length of the side stick is the difference in height of the side forms and the finished surface at the center of the road or street, plus or minus the length of the T's, depending on whether the finished crown at the center is above or below the top of the side forms.

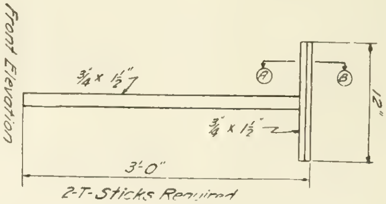
When this difference is accounted for, the notch for the quarter points is determined by dividing the crown of the pavement by 4. The result is the difference in elevation between the center and quarter points in the finished surface.

Setting of the center and quarter pins is applicable only on roads or streets up to 30 ft. wide. Wider streets should have the center pin established and not fewer than 5 to 9 pins additional should be set. The ordinates of the arc or crown should be calculated for each pin.



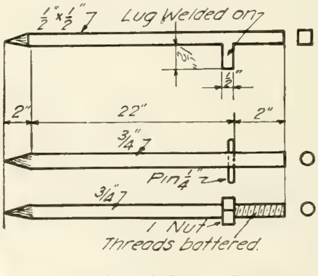


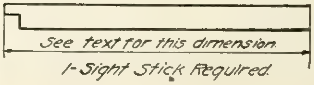




One inch for each pin should be cut in the side stick, depending on the number of pins used from the side form to and including the center pin.

After placed on the subgrade, the concrete is ma-





The Lute in Use on Sheridan Road, Winnetka, Ill.

nipulated with the lute to move it as may be necessary. The operator stands with his back to the mixer, working in the direction in which concrete is being placed. If it is necessary for him to walk on the luted surface, the concrete surrounding the boot holes should be thoroughly stirred up so that the holes will be filled with a mixture similar to adjacent concrete.

Luting brings the surface to a general grade only. It moves the concrete from the places where it is high, to the low spots, and a surface is obtained which does not show more than ¼-in. depressions. These are later removed by the roller and belt.

## New Assessing System Includes House Survey

An efficient method of arriving at property valuations for tax assessing purposes in smaller cities has been employed for several years at Appleton, Wis., and is now being tried out at Owatonna, Minn. The plan was described as follows by Mr. Harry Dartt, city engineer of Owatonna, in a paper presented at the last annual meeting of the Affiliated Engineering Societies of Minnesota.

Heretofore the assessor in Owatonna has been employed from May 1st to July 1st with enough assistants to enable him to complete his books by July 1st. Under the charter the assessor is appointed by the City Council. The average cost of assessing the city the past 10 years has been about $1,000 per year. The Council have now adopted a new plan as follows:

The assessor is elected for the year, at a salary this year, of $1,000. The first 6 months, or until July 1st he will be employed at his regular duties of assessing real and personal property, except that he will do all the work himself without assistance. After July 1st until cold weather sets in, he will be employed in making house surveys in preparation of a plat system. From cold weather until his duties in assessing personal property begin next year, he will be making plats, and perfecting information sheets of the system described below.

Each piece of real estate on which there are structures will be represented by a loose-leaf sheet 11x14 in. in size, bearing the title "Assessors' Information Sheet." The face will show a plat of the premises with as much detail as is desired. Dimensions of lots and tracts, outside measurements of structures, height of walls, concrete walks and drives, and possibly shade and orchard trees will be shown on the plat.

Property without structures may be shown, including topography, fields, timber, wet lands and watercourses. The latter feature probably would be most valuable in showing valuations of outlying garden tracts and small farms within the city limits.

On the reverse will appear a questionnaire giving detail information as to the construction of buildings; roof, walls, floors and finish, plumbing, heating, lighting, etc.

In this case of a city of 7,000 population, about 1,700 lots and tracts will require that many sheets. 2,000 will be printed. It is planned to use five binders containing about 400 sheets each. Tabbed index sheets will separate the different additions and all will follow the order of the descriptions in the tax-books.

For field use in making house surveys, sheets 8½x11 in. will be printed with the questionnaire on one side and the plat with the measurements will be pencilled on the other side.

The preparation of the new system has been placed under the supervision of the City Engineer but the Assessor will do all the work, including the making of the plats.

It is estimated that the system will be completed in 2 years with no more expense than the average annual expense of assessing the city.

It is anticipated the system will bring the following results:

1st. Arrive at more even valuations by having one man do all the assessing.

2nd. Enable the Board of Equalization to act with more intelligence in adjusting disputed valuations.

3rd. Force the assessor to show a foundation for his assessments.

4th. Furnish valuable information to those officers and employees having to do with the building, electric, plumbing, and water-works ordinances of the city.

## 2-In. Water Pipe Used for Rolling Concrete Pavement

A length of 2-in. wrought iron water pipe filled with sand was used successfully in rolling a New York state concrete road. The paved surface was 35 ft. wide, the middle 19 ft., being occupied by a 2-track street railway. This section was surfaced with 2-course concrete; the rest of the paving was 1-course. The roller, one end of which rested on the outside form and the other on the outer rail of the track was pushed ahead with the foot. As a result two men could handle the spreading and finishing of the concrete. The batch was spread a little high with hoes and was then rolled into shape with the pipe. An 8-in. wrought iron pipe also was tried on the work, but failed to give as good satisfaction as the smaller size.

## Method of Repairing Uneven Joints in Concrete Road

Uneveness in a number of joints of the Toronto-Hamilton, Ont., concrete highway, caused by heaving of the slabs was remedied by chipping off the high places or by building up an approach. The joints causing a severe jar to vehicles were chiseled through and filled with a mixture of tar and crushed gravel. Where it seemed probable the slabs would return to their original position the abrupt offset was improved by by building up an approach, in some cases 18 in. wide, with tar and pea gravel. In cases where it seemed likely that the slabs would not settle back to place the joints were chipped off with a mason's hammer. This chipping was limited so that the thickness of the slab was not reduced more than 1 in. This formed a satisfactory and low cost method of removing the minor inequalities.

**Boiler Serves as Standpipe for Concrete Road Water Supply.**—An old boiler shell, 5 ft. diameter and 25 ft. long, up-ended and set in a base of concrete served as a standpipe on a concrete road job. On this work the water had to be pumped a maximum distance of nearly 4 miles. The standpipe and a rotary booster pump were employed to keep up the pressure.

# City Planning for Small Municipalities, with Special Reference to an Industrial Survey

The planning of small cities is as important to the efficiency of the nation as a whole as is the planning of larger cities. It has been thought comprehensive planning relates more to larger cities than to those of 100,000 population and under. This, stated Mr. A. Pearsons Hoover, Consulting Engineer, New York City, in an address at the last annual meeting of the City Managers' Association, has been more or less due to the assumption that planning is not necessary until a city has reached a certain population. Small cities, according to Mr. Hoover, have a distinct advantage over larger cities in city planning, for they can take the experience and mistakes of the large municipalities as their example for future development. In order to comprehend fully the vital need of comprehensive planning for small municipalities one has but to examine the enormous expenditures made by large cities to rectify existing conditions. Further extracts from Mr. Hoover's paper follow.

**Planning of Streets Important.**—In the arrangement of streets the small city can be guided by the lessons learned by larger cities. Here again should the importance of comprehensive planning be felt by the small cities. The street system of every municipality is directly related to topographical conditions as well as to the intensified use of certan sections. Certain streets should always perform and serve a distinct function in respect to traffic, if the development and improvements upon the land are followed out upon a comprehensive plan for the future.

The value of a street system depends in a certain measure upon the extent of its diagonal highways and major thoroughfares, and the value of any diagonal highway or main thoroughfare depends upon the connections served to different sections. The small city should feel the importance of providing means for the widening of certain streets to meet future requirements. This can be accomplished at the time when improvements have not yet become intensified by making provision for the ultimate widening of such streets to provide for the traffic which they shall be called upon to handle, when the city has increased to a certain population and covers a contemplated area.

**Transit Problem.**—In the planning of small cities one important question to be studied in the light of present needs and future growth and possibilities, is the transit problem. Mistakes made in the larger cities by permitting transit facilities to develop indiscriminately so as to feed and tap certain localities, have been a source of great importance to the community. To rectify such mistakes the expenditure of huge sums of money has been necessary. To utilize the best facilities for transportation in the small city is to plan and lay out for the future growth.

The small city should lay out on a comprehensive plan all the transit facilities that will be required to meet demands far in the future, based upon past record of growth. To be able to transport workmen or mechanics quickly to and from work is of vital importance in the development of any community. In all cities thought should be given to the possibility of future need for elevated systems or subways and in connection with such rapid transit facilities consideration should be given not only to the location of stations, but to the intersection of streets, where it is likely that subways will be required, so that curves may be located from cross street to the main avenues without the demolishing of buildings or the heavy expense of underpinning large superstructures.

**Grade Crossings.**—In the planning of small cities the question of the elimination of grade crossings arises. It is well known that in several communities the cost of eliminating grade crossings, under present conditions, amounts to considerable more money than if this problem had been studied in the past with an eye to the future growth. In this problem alone the small city is in a more advantageous position relative to city planning than is the larger one whose development has been allowed to continue without any comprehensive plan.

**Districting of City Important.**—One of the most important subjects in the development of the small city is the vital question of districting. To be able to district means the ability to set aside certain sections for certain usages. The districting of certain sections of the small city for future growth and development means that the small town will automatically assume the shape of an economic and efficient municipality. Districting means the healthy development of the whole community on broad lines and on an economic basis. It means the stabilizing of real estate values. It means the producing of the best the community affords relative to its natural resources and geographical location.

**Development Depends on Industrial Progress.**—A small city depends for its development greatly upon its industrial progress. To be able to operate industries efficiently and to be able to produce commodities cheaply depend upon the efficiency of the industrial section. Without industrial efficiency municipal expansion cannot obtain. The question resolves itself into the vital need, together with city planning, of an industrial survey.

**Object of Industrial Survey.**—An industrial survey means that a comprehensive plan and study is made of the resources of the industrial community. These resources are tabulated and analyzed and upon the results recommendations are made for the rectifying of present mistakes and suggestions for economic future growth. An industrial survey means an inventory of the industrial section. It means the study of the different elements entering into the industrial community, to be able to plan a healthy growth for the future. It denotes the same for an industrial community as does the taking of stock in and the laying out of efficiency lines of the different departments in a large industrial plant. It means to so regulate and so locate the different industries in the section that each shall receive the services required with the services that can be offered.

The industrial survey places economy and efficiency in operation above all else. It emphasizes the need of co-ordinating the different transit facilities, industrial locations and the development of the natural resources near or adjacent to the municipality, to bring about efficiency in production and efficiency in management. Lack of appreciation of the advantages of the natural resources of any municipality can only hamper the normal and healthy development of industrialism. Industrialism can reach its highest development only when equal opportunity is secured to all and when reward is equitably proportioned to services rendered. It can reach its highest development only when appreciation is thoroughly sensed of the vital importance for an industrial survey as a means of bringing out clearly the production on economic lines of raw materials near at hand.

**Suggested Industrial Survey Program.** Briefly, the industrial survey would in general cover the following subjects:

An analysis of the present transportation facilities showing their advantages, needs and future expansion.

Analysis of the transportation charges and plan for readjustment so as to increase more effectively the interchange of commodities.

Study of the position of the municipality with respect to other commercial centers of the country.

Study of the position of the municipality as a center for certain types of industries with analyses showing why and how certain industries would be developed.

Study of the relation of the municipality in regard to the development of any distinct line of transportation.

An analysis of the industrial section with plans for present improvement together with suggestions for future development.

An analysis of the present industries with suggestions for development in the future.

An analysis of the labor condition in regard to present industries together with suggestions as to the kind of labor necessary for certain industries which should be developed.

An analysis of the housing problem in conjunction with the labor system.

## Cost of Constructing Macadam Pavement at Hamilton, Ont.

The following figures from the report of E. R. Gray, City Engineer of Hamilton, Ont., for 1916-17, show the unit cost of constructing 2,361 sq. yd. of macadam on the northerly half of Burlington st. The macadam consisted of 5 in. of bottom stone and $3\frac{1}{2}$ in. of top stone, requiring 897 cu. yd. stone and screenings loose measurement, or 559 cu. yd. in place. This was 1.6 cu. yd. of stone, loose measurement, for each cubic yard in place. The cost of work was as follows:

| Operation. | Quantities, etc. | [illegible] | Cost per sq. yd. |
|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] |
| Bottom stone | [illegible] | [illegible] | [illegible] |
| Hauling bottom stone | [illegible] per day, 4 trips). In- [illegible] | [illegible] | [illegible] |
| Laying bottom stone | [illegible] | [illegible] | [illegible] |
| Rolling bottom stone | [illegible] | [illegible] | [illegible] |
| Top stone | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | .015 |
| [illegible] | [illegible] | [illegible] | .13 |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | .036 |
| [illegible] | [illegible] | [illegible] | .015 |
| [illegible] coal, etc. | | 139.92 | [illegible] |
| [illegible] | | [illegible] | |
| [illegible] cent of $1,360 | | 68.00 | .02[illegible] |
| | | [illegible] | [illegible] |

The labor cost of unloading the stone from cars using hoppers was 22.8 ct. per ton or 54 ct. per load, the latter averaging 2.37 tons. The labor time for unloading 370.8 tons from 7 cars was $241\frac{1}{2}$ hours at 35 ct. per hour.

## Location of Earth Roads*

### By R. E. LOUCKS

In a province such as Saskatchewan, where the supply of gravel for surfacing roads is somewhat limited and as yet undeveloped and where distances are so great and settlement so sparse a large percentage of our public highways must of necessity be earth roads.

Much can be accomplished in road making by using the proper materials and equipment, by efficient organization and supervision of construction, yet this may be more than offset by bad planning. Bad planning of roads retards the progress of any community —by increasing the cost of haulage up steep grades and over greater length than is necessary. This tends to scatter the population so that the amount of road to be built and maintained is not in keeping with the financial status of the taxpayer.

Roads should be located by engineers governed by the principle of balancing the lengths and grades that a minimum effort will be required to go from one end to the other. Since the introduction of self-propelled vehicles, with their greatly increased radius of action, the loss of time, energy and money caused by lack of directness in highways has been more apparent, and it is obvious that any intelligent plan for the improvement and extension of a new system must include the correction of alignment in existing roads and provision for direct routes between important centers.

In Saskatchewan the engineer is given very little latitude as to the location of roads. He must adjust his scheme to fit into the system of rectangular subdivision into which this province is surveyed. This is not always and easy task. In passing, however, it is doubtful if any better system of laying out our prairie lands, having regard to all the conditions, could have been evolved. On the other hand, the sooner we abandon the idea of sticking to these rectangular allowances, whatever obstacles may be encountered, and freely divert our roads to suit the topography of the country, the sooner will we lay the foundations for a wise and permanent system of highways.

In locating our roads we must remember, too, that, generally speaking, the road will be constructed from the material over which it passes, so it will be well to study the nature of the soils and avoid where possible swamps, sloughs, alkaline areas, etc. This is desirable not only on account of the poor nature of the road-making qualities of the soil, but also on account of the difficulty of draining.

In any system of highways there must be certain focal points of varying importance. Traffic increases as such points are approached, and hence the capacity of the roads must increase in like proportion. The gradients of main thoroughfares should be made as light as possible, both for the reason that loads are heavier, and that lighter gradients permit higher speed and therefore greater capacity. Present centers will increase in importance, but not in the same ratio. What is today a subordinate center may in another decade be of relatively greater importance, and the highways approaching it may have to be widened and improved in alignment; hence it is important to give careful consideration to the location and width of each particular road of the system in order that the cost of such future improvement may be minimized.

The principles which should govern the creation of a system of highways in a city are quite similar to those applying to a state or a county. The city will also have one or more principal traffic centers and a number of subordinate centers. Direct connections between these centers are of prime importance owing to the heavier loads and the lower speeds enforced by greater volume of traffic. It is a mistake to treat a city and a contiguous rural system of highways independently of each other. The motor car has placed the city in such close relation with the rural districts surrounding it and with the neighboring towns, and ther interdependence has become so great, that the entire system of highways, both rural and urban, must be considered as an entity.

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*[illegible]

The chief highway connecting two towns should afford a direct connection between the important thoroughfares of each. Frequently this is not the case, but the main and sometimes the only adequate road connecting them leads at either end into narrow, tortuous, and shabby streets which must be traversed in order to reach the business and administrative center. How different an impression one will obtain and how largely will the pleasure, comfort and convenience of a journey be increased if the approach to a town is through a dignified, well-paved thoroughfare constantly increasing in importance and interest until the climax is reached at a well-designed and convenient civic center.

In the creation of radial roads a difficult problem is frequently presented by the same town or village through which such roads would naturally pass. It rarely happens that any of the town or village streets are of sufficient width to provide the needed capacity. Their widening would involve expense which might be prohibitive and would be violently opposed by those who, attracted by the quiet of the village street, have made their home there and do not wish to see it converted into a busy thoroughfare. In such cases it is usually possible, by a slight detour, to avoid the local street, save the expense of widening and return to the existing road at a convenient point beyond the town. At the same time, new impetus will be given to the development and improvement of the land along the new highway, while the character of the older portion of the town will be preserved. This plan of adopting the "by-pass roads" is simply following the lines of least resistance and may go far towards overcoming the local opposition which frequently develops when any change is suggested.

**Curves.**—Curves should be planned to afford a sight distance; that is, the greatest distance at which the drivers of two approaching vehicles may see each other's machine, of not less than 250 ft. This would afford the driver of each of the approaching vehicles a distance of 125 ft. within which to come to a halt. In the case of automobiles traveling at the rate of 15 miles per hour, a maximum of 6 seconds would be provided to bring either machine to a standstill before collision.

The radii of the curves will depend on the speed of the traffic. On the level stretches of roads and on those with gentle gradients, upon which naturally motors are driven at top speed, sharp curves are especially troublesome and dangerous at the same time, if they interfere with the proper outlook. In hilly districts, on the other hand, motor cars going both up and down hill are naturally obliged to proceed at much lower speeds, at which they can easily take the sharp curves which have to be adopted on such roads owing to the limitations imposed by the configuration of the ground.

It would seem advisable to set a minimum radius of 300 ft. wherever possible without incurring a prohibitive cost. If the radius has to be shortened to 150 ft. and under, danger signs should be placed at least 400 ft. from the B.C. and the E.C.

When a curve occurs on an ascent, the grade at that place should be diminished in order to compensate for the additional resistance of the curve. When it is necessary to make a radius of curvature less than 300 ft., we should follow the principle of reducing the grade on the curve at the rate of 1 per cent for every 50 ft. that the radius has to be reduced; so that where we are locating a 5 per cent grade and have to put in a curve of 200-ft. radius we give a 3 per cent grade. On curves with a small radius the employment of transition curves is desirable. As a rule, there ought to be a tangent of about 100 ft. between two curves. Quick reverse curves are disagreeable and dangerous with automobile traffic and are to be avoided.

Where the road is to be located along the slopes of ridges and a choice of ridges is available, those affording the greatest protection against the action of prevailing storms should be selected. The advantages resulting from such a choice will be greater freedom from the effects of heavy rains and drifting snow.

A development in street improvement resulting from automobile traffic is the demand for curves of larger radius at the corner of street intersections. Past practice resulted in a corner that was nearly square, or had the curve varying from 4 to 10 ft. radius. This means that the vehicle could not turn into an intersection street until it had passed the corner. The driver of a car must either shift gear and slow down to a suitable speed for the turn, or else he may take the turn with an abruptness that is a menace to other vehicles as well as pedestrians. A further alternative practiced by many drivers is to swing widely at the turns, a practice which carries them to the wrong side of the roadway and risks accident.

Toronto, Ottawa, Windsor, Stratford, Chatham and other cities in Ontario are widening and rounding many of their street intersections. The increasing radius of the curves enables an automobile to follow a course parallel to the curb and keep to the right of the roadway, with greater convenience and safety.

**Essential Considerations.**—The most essential considerations which should govern the location of the individual road or a complete highway system may be briefly summarized as follows:

1. Adequate drainage must be secured by systematic planning of the complete road system and avoidance where possible of low areas and objectionable soils.

2. The grade must be so planned that a minimum of effort will be required to go from one end of the road to the other and so that a minimum of waste results from construction, having regard to ruling grades on the particular road in question.

3. The road while not monotonously straight, should be as direct as the topography and limiting grades will permit.

4. Danger points should be avoided at any cost. "Safety first" is a good slogan for engineers on road location to adopt.

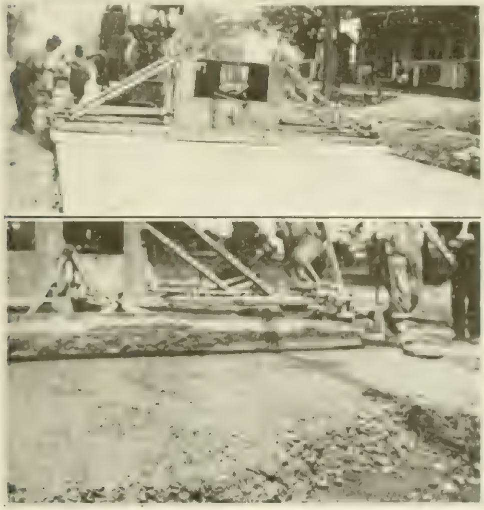
5. Roads should be made interesting where possible. Picturesque vistas and extensive outlooks are desirable as well as easy gradients and a smooth surface.

6. Every road should form a part of a scheme, which scheme should be planned in advance of location and construction under the guidance of a competent engineer.

## Road Finishing Machine Produces Denser Concrete

A concrete road finishing machine that eliminates the voids in concrete and permits the use of a drier, coarser mixture than could be worked by hand is being employed by Keeley Bros., Contractors, East St. Louis, Ill., on their road job at Belleville, Ill.

The machine moves forward under its own power at a speed of about 7 ft. per minute and backs up at a speed of 28 ft. per minute. As the machine travels forward the strike-off spreads the concrete to the necessary height and proper crown. The tamper, located just back of the strike-off, tamps the concrete the first time over with a long, hard stroke. The second time over a short, rapid, up and down movement is used, which may be decreased until it is subjecting the concrete to continuous agitation without applying pressure to the mixture. The stroke of the tamper is regulated by the operator and may be varied for different consistencies of concrete as well as for different stages of progress. The float, located at the rear of the machine, produces a smooth finish by sweeping a belt across the surface at a comparatively slow speed.



Top View: Lakewood Concrete Road Finisher in Service on Belleville Road. Lower View: Dry Mix Used With the Finisher

By subjecting the mixture to the continuous agitation caused by the tamper, the concrete is compacted and the air in it is brought to the surface. The larger stones and only enough mortar to cement them are brought together. Because of the agitating action of the tamper, a drier mixture can be used with the finisher than would be possible where the work is done by hand. This, of course, results in a stronger concrete and produces a surface free from laitance, silt and light particles which float to the surface of a wet mixture.

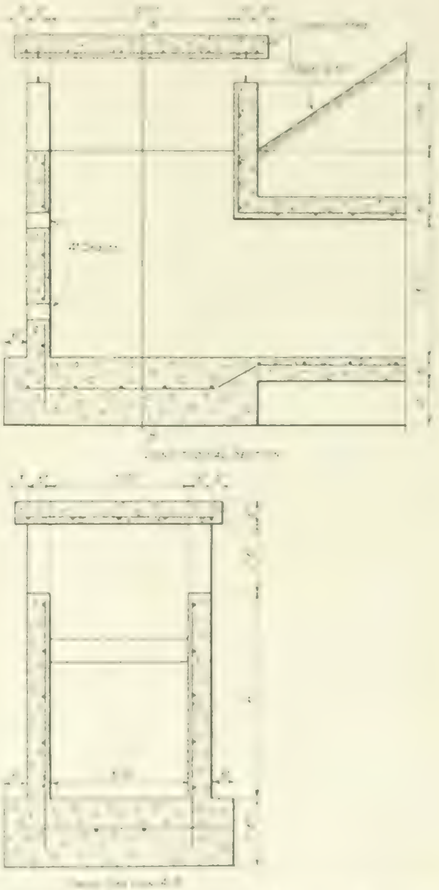
The illustrations show the finisher in use on the Scott Field road, Belleville, in St. Clair County, Illinois. This concrete road will be 6 miles long, 15 ft. wide, 6 in. thick on the sides and $7\frac{1}{2}$ in. thick at the center. A $1:2:3\frac{1}{2}$ mix is being used.

The device was designed in 1913 by Mr. E. G. Carr, while a contractor in California, and has been used on the construction of about 400 miles of highways in that state. With the assistance of the staff of the Lakewood Engineering Co., Cleveland, the mechanical details have been refined and the machine has been placed in production by that company.

D. O. Thomas is County Highway Engineer and Frank Sheetz is Engineer in charge of the work.

## Drop Inlet Culvert Reclaims Adjacent Farm Land

A type of drop inlet culvert, used by Mr. E. B. Hiatt, County Engineer of Madison County, Iowa, to care for the fall when there is considerable difference in elevation on opposite sides of the roadway, is shown in the accompanying drawing.



Section of Drop Inlet for 4 ft. x 4 ft. Reinforced Concrete Box Culvert

The drop inlet and culvert are constructed of reinforced concrete. The top of the inlet is brought up to a point about 4 ft. below the road grade whenever such construction is possible. A concrete slab supported on four small concrete blocks is placed over the top of the inlet to serve as a cattle guard and to prevent debris accumulating over the mouth of the inlet. The drop inlet is of rectangular shape, of the same area as the culvert barrel. The purpose of this type of inlet is to collect the sediment carried by the stream and deposit it around the inlet. In this manner it fills up the adjacent area to the same level as the top of the inlet. It not only reclaims the adjacent farm lands, but in a measure protects the culvert itself against erosion. In some cases the barrel of the culvert is extended beyond the right of way and the intake placed inside the farmer's fence.

## Cost of Street Flushing and Squeegee Work at St. Paul

Street flushing in the business district of St. Paul, Minn., in 1917 cost 24.7 ct. per 1,000 sq. yd., according to the last annual report of M. N. Goss, Commissioner of Public Works. All streets in a portion of the business district are flushed every night during the season. This district has 7.12 miles of streets or a paved area of 146,400 sq. yd. Three horse drawn, Studebaker flushers were used for this night work. The crew consisted of a foreman, three teams and two gutter cleaners; they worked 8 hours. The average cost of operating one flusher on this night service was $12.07. This includes payroll, oil, waste, gasoline, water and repairs to equipment. Six flushers, working 9 hours per day, were operated during the day shifts on streets outside the business district; they work 9 hours. The squeegees were used entirely on smooth pavements such as asphalt and creosoted blocks. The entire department has five machines. The cost of the squeegee service in the business district outside of the "Night District" was 15.5 ct. per 1,000 sq. yd. scrubbed once. The cost of this service in the outlying districts was 27.7 ct. per 1,000 sq. yd. for one scrubbing. This higher cost in the latter work was due to the necessity of having the squeegees followed by a pick-up wagon to clean up the gutters. In the down-town district this service is performed by the teams hauling street sweepings.

Paved streets in the residence district were flushed or scrubbed at least once a week and oftener when necessary.

## Non-Slip Paving for Bridge Approaches

Steps were taken last year by the Division of Bridges of Chicago to develop a block pavement that would afford a good foothold on bridge approaches. The Lake St. bridge was selected for the experiment. The existing block paving was taken up and relaid with a strip between each row of blocks. This strip was 1 in. x 2½ in. and was toenailed to the subplank of the span, so as to retain the blocks when the bridge is in the open position. Grout was placed on top of the strip to a point about ½ in. from the top of the block. This gave a corrugated pavement and the roughness of the grout surfaces aided considerably in giving a foothold for the traffic. The pavement, according to the last annual report of the Department of Public Works was far more successful than anything tried before.

**Truck and Tractor Exhibit.**—The second annual national exposition of trucks, tractors and accessories will be held Sept. 14-21 at the Municipal Pier, Chicago, Ill.

## Cost of Street Cleaning at St. Paul by Patrol System

During the season of 1917, 58 miles of streets (1,347,051 sq. yd.) of pavements were cleaned by the patrol system (White Wings). The other paved streets were cared for by the ward crews. The total cost of the patrol system, according to the last annual report of M. N. Goss, Commissioner of Public Works, was $70,178 or an average cost of $52.09 per 1,000 sq. yd. per season. The above figures include the cost of shovelers and teams hauling away the street sweepings. The area handled by one man was from 3,200 to 17,600 sq. yd. The force consisted of an inspector at $100 per month, an assistant inspector at $90 per month, from 105 to 125 sweepers, 14 teams at 66⅔ ct. per hour and 15 shovelers at 25 ct. per hour. The working day was 8 hours.

## Labor Cost of Monolithic Brick Pavement

Monolithic brick pavement was constructed on the Highline Road in King County, Washington, at a labor cost of about 23 ct. per square yard. The paved section was 20 ft. wide. The concrete base was a 1:3:6 mix, 3 in. thick at the sides and 5½ in. at the crown. The blocks for part of the work were vertical fiber bricks, 4x8½ in. x 2¾ in. deep; for the remainder standard paving blocks 4x8½ in. x 3½ in. deep, laid flat, were used. The average labor cost for 91,500 sq. yd. of pavement laid between June and October, 1916, was as follows:

| | Per sq. yd. |
|---|---|
| Concrete base, 4-5 in. thick | $0.086 |
| Sand-cement cushion | .018 |
| Laying brick | .072 |
| Grouting | .033 |
| Sprinkling | .005 |
| Curb forms | .012 |
| Total | $0.226 |

The above figures include the cost of covering the completed pavement with 1 to 2 in. of earth and removal of same. The average paving crew was as follows:

| | Per day | | Per day |
|---|---|---|---|
| Superintendent | $6.00 | Brick crew: | |
| Mixer crew: | | 1 bricklayer | $7.00 |
| 1 foreman | 4.00 | 1 batter-in | 3.00 |
| 1 mixer engineer | 5.00 | 1 liner | 2.75 |
| 2 subgrade men | 2.75 | 6 carriers | 2.75 |
| 4 shovelers | 2.75 | 4 pilers | 2.75 |
| 8 wheelbarrow men | 2.75 | Grout crew (8 laborers) | 2.75 |
| 2 cement men | 2.75 | Covering, uncovering and sprinkling (2 men) | 2.75 |
| 2 concrete spreaders | 2.75 | Curb forms: | |
| 1 concrete rodder | 2.75 | 1 man | 4.00 |
| Cushion crew (5 men) | 2.75 | 1 helper | 2.75 |
| | | 1 water boy | 1.50 |

The concrete for the base was mixed in a 21 cu. ft. Koehring mixer of the boom and bucket type. The 1:3 sand cement cushion was mixed in a 3-ft. Little Wonder mixer. The bricks were handled by laborers with brick clamps.

## Average Costs of County Roads in Iowa

The following tabulation from the Service Bulletin of the Iowa Highway Commission shows the mileage and average cost per mile of county roads constructed during the past 3 years.

| | 1915 | | 1916 | | 1917 | |
|---|---|---|---|---|---|---|
| | Miles. | Av. cost per mi. | Miles. | Av. cost per mi. | Miles. | Av. cost per mi. |
| Roads constructed to perm. grade | 462.7 | $1,336.00 | 625.2 | $1,251.13 | 879.97 | $1,047.97 |
| Roads constructed to temp. grade | 355.9 | 682.00 | 108 | 926.93 | 40.60 | 1,732.62 |
| Roads constructed to nat. grade | 2,358.8 | 125.00 | 3,681 | 139.53 | 2,490.66 | 154.42 |
| Roads hard surfaced | 182.0 | ...... | 277 | 805.72 | 411.54 | ...... |
| Roads dragged av. of 29 times | 15,400.0 | ...... | 14,927 | 24.90 | 15,724.00 | 24.04 |

# Iowa Methods of Constructing Gravel Roads

Gravel is the most widely distributed road material in Iowa, and as a consequence many miles of this type of highway have been built in the state. In 1917 alone over 406 miles of gravel road were constructed by the various counties. The methods employed in gravel road construction in this state are outlined in a Service Bulletin of the Iowa Highway Commission, from which the matter following is abstracted.

**Iowa Standards for Gravel Roads.**—The Iowa standards provide for two classes of gravel road construction: Class "A" and Class "B." Class "A" is the more expensive type of gravel road to build. It requires, in a general way, 2,400 cu. yd. of gravel per mile, the thorough packing of the subgrade, and depositing of the gravel in two layers, each of which is thoroughly worked to secure even distribution and then packed, either by rolling or traffic. If properly built of good road gravel, it undergoes heavy traffic without humps, and wears well. If the money is available, practically all road builders will recommend it in preference to the cheaper type.

Class "B" gravel road is constructed by depositing the gravel upon the existing earth road and allowing it, in many cases, both to be distributed and packed by the regular traffic on the road. Between this method of construction and the best grades of Class "A" construction, there are all degrees of care and lack of care in gravel road building.

Upon the care in construction, the ultimate satisfaction a community gets from a gravel road will depend almost entirely. No type of road shows more beneficial results from careful attention to a few essential details in construction. No class of road can give much more exasperation to a community if all attention to proper methods of construction is neglected.

**Properly Graded and Drained Roadbed Necessary for Foundation.**—The first requisite in building a gravel surfaced road of the Class "B," or any other surfaced road type, is a properly graded and drained dirt road for a foundation on which to build. The dirt road should be permanently established, with all cuts and fills made and the roadbed graded, shaped and slightly crowned. Before gravel is placed, the grade should, if practicable, be packed by traffic or weathering through two or more seasons. Seepy, springy places should be gotten rid of by drainage. Side ditches should be clean and ample. Side ditches themselves should drain. It is not enough to have the road surface water run into the side ditches and remain standing in pools in them beside the road grade. Water standing in side ditches keeps the earth of the road grade wet and spongy. Such a grade or fill cannot produce a solid foundation for gravel or any other kind of surfacing. Concrete, monolithic brick or types of pavement with concrete foundation can, and do bridge over soft places in the subgrade and support traffic to a certain extent, though the tendency in even the highest and most expensive class of pavement is toward failure over any weak spot in the subgrade or foundation. It is more or less a waste of money and time, or at least a gambling chance to attempt to build a road surface of any type over a foundation that is not firm and solid. A gravel surface which has no bridging qualities to protect itself over soft places must have a solid and firm foundation if any success at all worth the time and expense is secured.

With the earth road, permanently graded, thoroughly drained, packed by weathering and traffic, the vital problem is to secure good gravel with enough clay for binder and get it properly placed on the road. The location of good gravel for the purpose is the first requisite. In counties where there are gravel pits, persistent searching is sometimes necessary before satisfactory road building deposits are located. Just as much care should be exercised in the purchase of gravel for shipment as in locating a satisfactory home deposit.

**Hauling, Spreading and Packing the Gravel.**—The majority of the counties use the ordinary farm wagon with dump boards for hauling the gravel. Most of the loading is done with hand shovels. The attention needed to make a good gravel road begins with the loading in the gravel pit. The character of the deposit ordinarily is not of even quality throughout the pit. To secure good results, the gravel placed on the road should be of even quality. The dumping of a load of gravel with considerable fine sand with little binder, adjoining one of coarser material with plenty of good binder, is sure to result in more or less of a wave in the road surface, for the wear will be unequal. Better results will be obtained if that portion of the deposit with the fine sand for instance, is all loaded out in successive loads and dumped on the road together. The same is true with all other variations in the deposit.

On some road jobs a steam roller is used as a tractor for pulling an ordinary blade grader, the first half of the gravel being spread on the first trip round. Following the first spreading, which is usually accomplished with one round trip, the spring tooth harrow is put at work. The harrow continues the mixing process and makes the distribution more even. After a passage or two of the harrow, the uneven places where the ends of the loads butt together are almost entirely wiped out. It is impossible except where loads of different quality of gravel adjoin to tell where one leaves off and the next begins. This is absolutely essential if the road is to be free from humps and waves.

After the harrow has finished its job of mixing, evening and distributing, the blade grader is sent over the road for another round trip and the road is ready for traffic to begin its packing. If the gravel is moist, the packing starts at once and in a few days a good smooth riding surface may reasonably be expected. The dryer the gravel and clay, the slower the packing process. Under extremely dry conditions, there sometimes is almost no packing effect noticed until after a rain. The early stages of the road require a constant watching. As soon as the gravel shows a tendency to rut up, the grader should make another trip, throwing the gravel more to the center and smoothing it up again. This should be repeated as often as necessary. The number of times it will be necessary to use the blade grader, depends on the quality of the gravel, the amount of binder, the amount of moisture and the character of the traffic the road must undergo during the packing process.

While the spring tooth harrow is often used, almost equally good results can, with care, be obtained with a heavy spike tooth harrow, providing the teeth are long enough and the harrow heavy enough to penetrate the gravel body. The field disk does good work, thoroughly kneading and working the gravel body, but the disk does not produce the same even distribution that results from the use of the harrow. The heavy disk, however, is far better than a light harrow which slips merely over the top surface of the ground and does not penetrate entirely through the mass. For obvious reasons, the spring tooth harrow produces the best results.

The harrow, especially the spring tooth, works the small stones to the surface. After a passage or two with the harrow, practically all the stones are brought to the surface. The stone should by all means, be thrown off the road. They should not be buried in the gravel body. If left on the surface, they result in serious damage to car tires and if in quantity or of large size are a positive danger on the highway. On the Ames-Des Moines road school boys were hired to pick the stone from the road on Saturday vacation.

If buried in the gravel body, they produce a spot which wears unevenly. If many stones are in the road, they produce a very rough riding surface and one that is extremely hard on tires.

The harrow tends somewhat to wipe out the uneven quality of the gravel due to dumping of loads of varying qualities of gravel adjoining each other.

In conclusion, it can be said that the first requisite in building a successful gravel surfaced road of the Class "B" type is a well-graded, slightly flat crowned earth road as a foundation on which to build.

Second—Gravel with sufficient clay to bind the mass together and cause it to pack under traffic.

Third—Dumping of gravel of even quality, together on the road.

Fourth—Even distribution and spreading by the blade grader.

Fifth—Disking and harrowing to cause even distribution and to work stones to surface for removal.

Sixth—Use of blade grader to reshape gravel as often as necessary while packing by traffic is in progress.

Seventh—Maintenance with drag or blade grader when surface is softened following the summer rains.

## Maximum Road Grades and Topography.

According to the best current practice, the maximum grades for roads that are of sufficient importance to warrant a highly improved surface is determined in great measure by the topography of the region traversed. The usual ranges for various conditions of topography are given as follows by Mr. Charles H. Moorefield, Senior Highway Engineer, U. S. Office of Public Roads, in a bulletin issued recently by the U. S. Department of Agriculture:

| | Per cent. |
|---|---|
| Coastal plain and prairie regions | 2 to 3 |
| Average rolling country | 4 to 6 |
| Hilly or mountainous regions | 6 to 8 |

## Auto Flushing at Chicago in 1917 Cost 7.7 Ct. per 1,000 Sq. Yd.

During 1917, 4,258,836,000 sq. yd. of streets of Chicago were cleaned by the block and gang system at an average cost of 31.4 ct. per 1,000 sq. yd. In the first ward (business district of city) 8,719,134 sq. yd. of sidewalks were cleaned by flushing at a cost of 9.9 ct. per 1,000 sq. yd. For this work 2,499,000 gal. or 4,105 tanks of water were used. Street flushing was carried out by horse-drawn flushers and auto flushers. By the first method 32,123,310 sq. yd. of street were cleaned, at a cost of 16.3 ct. per 1,000 sq. yd. For this flushing 19,382,880 gal. or 32,328 tanks of water was used. The auto flushers cleaned 19,374,496 lin. ft. of streets—a total of 103,149,745 sq. yd. The unit cost, according to the last annual report of the Department of Public Works, was as follows:

| | Per 1,000 sq. yd. |
|---|---|
| Expense, drivers and helpers | $0.039 |
| Gasoline, oil, etc. | .017 |
| Auto parts and repairs | .021 |
| Total | $0.077 |

## Cost of Shaping Up and Rolling Old Macadam

The cost of dressing up 12-ft. wide limestone macadam roads in Putnam County, Indiana, with a steam roller having a scarifier attachment ranged from $9.24 to $5.35 per mile in 1916. The average cost for the months of May, June, July and August of that year was about $7.08 per mile. The average total cost per day for the roller for this period, including coal, was $6.73. The cost of coal per day was $1.39. The above figures are based on the following costs:

| | |
|---|---|
| Coal | $3 per ton |
| Roller operator | 30 ct. per hour |
| Helper | 25 ct. per hour |
| Teams for hauling coal | 35 ct. per hour |

The average number of days operated per month was 24.6, the average number of miles covered during this time being 23.5 or about 0.95 mile per day. In most cases the roads were shaped up and rolled at the cost given above.

## Personals

Paul Starbird, county surveyor of Huron County, Ohio, has been given a commission in the Engineering Department, U. S. Army.

Wesley Rowell, for the past 2 years city engineer of Rensselaer, N. Y., has accepted a position with the Government for engineering coal in Virginia.

Charles E. Grubb, Wilmington, Del., has been appointed state highway commissioner for New Castle County, Delaware, succeeding the late James Wilson.

Charles H. Rust, for the past 6 years city engineer and water commissioner of Victoria, B. C., will engage in an engineering and contracting practice, with offices at Toronto, Ont.

Harold L. Gillette, assistant engineer in the Binghamton, N. Y., division offices of the New York State Highway Commission, has been commissioned a captain of engineers, National Army.

Edward R. Mack, park engineer of Wilmington, Del., has been given leave of absence to do Y. M. C. A. work in France, and Alexander Dougherty, his assistant, has been given leave of absence to go to Camp Dix.

J. Walter Ketler, for the past 10½ years chief structural engineer for Wendnagel & Co., Chicago, is a candidate on the Brundage-McCormick ticket for the republican nomination for representative in the General Assembly of Illinois from the Fifth Senatorial District, Chicago.

The following officers were elected at the recent convention of the Dixie Overland Highway Commission: Bert K. Smith, of Fort Worth, Tex., president; vice presidents, D. H. Dixon of Georgia; M. M. Cassidy of Forest, Miss.; Will Mercer of Shreveport, La.; Dr. S. M. Johnson of Roswell, N. M., and Ed. Fletcher of San Diego, Cal. Leland J. Henderson of Columbus, Ga., was re-elected secretary and treasurer.

Officers for the ensuing year were elected as follows by the League of Virginia Municipalities: Frank Talbott, Danville, president; Charles M. Brown, Roanoke, first vice president; George H. Cottrell, Staunton, second vice president; Edward R. Fuller, Richmond, third vice president; Royston Jester, Lynchburg, fourth vice president; L. C. Brinson, Portsmouth, secretary; R. E. Steed, Norfolk, assistant secretary.

## Obituaries

David Morgan, a contractor of Iowa City, Iowa, died suddenly last week at Baltimore, Md., where he was engaged in shipbuilding.

R. E. Todd, a civil engineer of Madison, Wis., died last week from a fractured skull, sustained while diving in shallow water.

Michael Dulenty, formerly assistant superintendent of the municipal asphalt repair plant of New Orleans, La., died Aug. 17.

Edward Wilson, a road contractor, of Nashwauk, Minn., was killed in accident Aug. 21.

## Trade Publications

The "Roll Call of Rex Mixers in Actual Service," is the title of a folder issued by the Chain Belt Co., Milwaukee, Wis. It contains an incomplete but representative register of those who are using three or more Rex Mixers.

The Permanent Highways Corporation, 502 42nd street, New York City, has published recently an interesting 20-page booklet describing and illustrating National Pavement. The publication contains information on the construction of this pavement, together with numerous letters from engineers where National pavement has been laid. Results of laboratory tests also are given.

The Butler Manufacturing Co., Kansas City, Mo., has issued a 6-page folder describing and illustrating the Furry concrete bridge and culvert form. This form consists of separate units and is adjustable for arched or rectangular shaped culverts or bridges.

*Waterworks and Hydraulics*
*Monthly Issue*

**ENGINEERING AND CONTRACTING**

Halbert P. Gillette, *President and Editor.* Lewis S. Louer, *Vice President and General Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering field. See advertising page for further information and subscription coupon

**Roads and Streets—1st Wednesday**
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies

**Waterworks and Hydraulics—2nd Wednesday**
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power

**Railways and Govt. Works—3rd Wednesday**
(a) Excavation and Dredging (c) Harbors and Docks
(b) Rivers and Canals (d) Railway Construction

**Buildings and Structures—4th Wednesday**
(a) Buildings (c) Steel Construction
(b) Bridges (d) Miscellaneous Structures

Volume L. CHICAGO, ILL., SEPTEMBER 11, 1918 Number 11

## 200,000 Men to Be Given a Collegiate Training by the Government

The Government is about to give 200,000 young men a college training at its own expense. Some 300 colleges will thus become akin to West Point, and the students in this new collegiate division will be enlisted privates, who will receive free tuition, board and lodging and $30 monthly salary. High school graduates, 18 to 21 years old, will be eligible, and apparently the Government plans to conscript nearly all the eligibles in the country for this collegiate division of the army.

This radical step is one that is likely to have a tremendous effect upon the engineering profession, for it is clear that practically all these students will be given a considerable amount of training in engineering. It is not unlikely that hereafter, instead of one West Point and one Annapolis, we shall have a hundred or more colleges in which young men will be given engineering and military training at the expense of the Government. Consider what is likely to be the outcome of such a plan. First, it will probably give the country 10 times as many engineering graduates annually as have hitherto been turned out. Second, it will focus the eyes of the entire country upon engineering education and the profession of engineering.

Engineers who look upon engineering as a narrow profession incapable of absorbing many more men without becoming overcrowded, will be apprehensive of their future. But engineers who believe that the demand for engineering services can be increased enormously, will have no fear. They will welcome this spectacular, radical departure from precedent, because it evidences a real public awakening to the worth of engineering. Of course the great majority of future engineers will not be engaged as designers and draftsmen, but as managers of industrial and political affairs. For scientific managers there is a field without limit. But coincidentally with the entry of many engineers into managerial positions there will occur a greatly increased demand for engineers as designers and planners; for scientifically trained managers understand the power of applied science and seek its aid from every source. There are about 10,000 chemists and chemical engineers in America, and one-tenth of this entire number is now engaged on research work by one company—the Du Pont Co. What chemist would have dreamed of such a thing four years ago?

There are probably not more than 100 engineers engaged as city managers and mayors, but the 12,000 municipalities that now lack scientific management would alone absorb all the civil engineers who have graduated in the past 12 years, were those municipalities to choose trained scientists as their executive heads. With the rapid increase in the use of machinery in farming and the adoption of scientific drainage, irrigation, fertilization, etc., agriculture alone will absorb engineers by the tens of thousands annually, once there comes an adequate popular understanding of the benefits derivable from applied science—engineering.

Let none of our readers worry about the radical step that our Government is about to take in higher, scientific education. But let us all unite to spread the gospel of engineering efficiency in every realm of human activity.

## Small Prospect of Rational Waterpower Legislation

Calvert Townley, one of the members of the Engineering Council, was delegated last January to appear before the Chamber of Commerce of the United States to discuss Federal legislation relating to waterpower. He began by making it clear that waterpower plants do not yield the enormous profits supposed to be secured by their owners. He pointed out that, contrary to general opinion, the cost of power by steam declined steadily during the 10 years prior to the war, at the rate of $2\frac{1}{2}$ per cent per annum, in spite of a 1 per cent average annual increase in the price of coal. The largest steam turbine today has 12 times the capacity of the largest reciprocating engine 15 years ago, and the first cost of such a steam-electric plant before the war was one-third as much per horsepower as 15 years prior thereto. Moreover, the power generated per pound of coal had increased 50 per cent in 15 years.

There are about 55,000,000 horsepower of undeveloped waterpower in America, and 6,500,000 of developed waterpower. In 1911 there were 26,000,000 horsepower of steam engine capacity, including locomotives. Three-fourths of the undeveloped waterpower is in 13 western states.

Congress is considering a new waterpower bill, but it is questionable whether it will be much of an improvement over the present law which has brought hydroelectric development almost to a standstill in the west. Without economic training and unaccustomed to seek engineering advice, the average Congressman knows as much about rational legislation in this matter as "the boy who shines the shoes of the man in the moon."

## A Paltry $100,000 Appropriated by Congress for Land Reclamation Surveys, and Why

Franklin K. Lane, Secretary of the Interior, recently asked Congress to appropriate $2,000,000 for surveys and engineering investigations of lands by the Reclamation Service. Congress has appropriated one-tenth what was asked, which is one-twentieth what was really needed. But the $100,000 will at least serve as a starter. There are approximately the following acreages of land that may be reclaimed in America:

| | |
|---|---|
| Stump land | 230,000,000 |
| Permanent swamp | 53,000,000 |
| Periodically swamp | 5,000,000 |
| Periodically overflowed | 15,000,000 |
| Wet grazing land | 7,000,000 |
| Arid land irrigable by storage of flood waters | 20,000,000 |
| Total | 330,000,000 |

The "stump land" includes inferior timber land. Since a great part of this land is hilly, it is probable that less than half of it will ever be used for farming. Even so there are nearly 200,000,000 acres of land that can be reclaimed and used for agricultural purposes. Mr. Lane advocates an immediate engineering study of this land with a view to beginning its reclamation as soon as the war ends. His foresight will be commended by every engineer who has given thought to land reclamation. It is a pity that the engineers of America did not send a delegation to Congress to aid in securing an adequate appropriation for the preliminary planning of this great work.

The war will probably end before the close of 1919, and several million men will be released from direct and indirect war service. Without question much public work will be undertaken to give employment to these men. But no great amount of public work can be started until surveys and engineering studies have been made. What are the engineers of American doing to make this fact clear to Congress, to state legislators and to city councils? Very little, indeed. If we are to lead the public let us show our capacity for leadership now. Let there be undertaken, at once, systematic propaganda to induce legislative bodies to order surveys and engineering studies of projected public works.

## Why Adjacent Waterworks Should Lay a Connecting Supply Main

Managers and designers of waterworks plants will often do well to adopt methods introduced by electric companies. For example, the hydro-electric companies of California are connecting their transmission lines, for the twofold purpose of insuring a continuous supply of current in case of accident to any generating plant, and of reducing the peak loads.

There are many villages and cities so close together that a similar connection of water supply mains would be similarly beneficial. This is particularly desirable where a city secures its water from only one source, for then in case of an accident, a disastrous fire might cost the citizens many times the entire investment in their water works.

Sometimes it is foolishly argued that because fire insurance rates would not be reduced even were two water supplies available, it is not economic to go to the expense of laying a connecting line of pipe. Those who take such a stand have evidently never been through a fire that has destroyed their business. Fire insurance, even where it entirely covers the value of the buildings, equipment and materials or goods, does not cover the loss of profits incurred while new buildings are being erected.

In these times when it is unusually difficult to get materials and equipment for buildings, and when the war has brought conservation of all resources to the fore, it is almost a crime not to connect adjacent waterworks.

## Bonus Payments to Firemen Effect 10 Per Cent Saving in Coal

Firemen working under a system that provides a bonus for efficiency in the use of coal are apt to resort to deception in their statements as to the weight of coal used. Deception of this sort is readily stopped by checking the daily fuel consumption reports against the bills for fuel.

In the most scientifically operated steam plants daily measurements are made of four factors that indicate fuel efficiency: (1) Flue temperature, (2) percentage of carbon in the ash; (3) percentage of carbonic acid gas in the flue gasses, and (4) water fed to the boilers. Based on such measurements an engineer can determine very accurately the efficiency of the firemen, boiler cleaners and fire cleaners every day in the year. Then a highly scientific bonus payment system can be applied. But even where such refinements are not practicable because of the small size of the plant, it is always feasible to use some sort of a bonus payment plan. Thus in pumping water a recording pressure gage and a venturi meter can be used to calculate the foot-pounds of useful work done each day. Then knowing the weight of fuel used to perform this useful work, it becomes easy to pay the firemen and others a bonus based on some assumed standard performance.

In the power plant of the Manila (P. I.) Electric Ry. & Light Co. a bonus system was introduced three years ago, and there has been effected since then a reduction of 25 per cent in the coal per kilowatt hour. Half this reduction is credited to the increased efficiency of the power plant men and half to improvements in the plant itself.

Edward N. Trump, at the last annual meeting of the American Society of Mechanical Engineers, said that fully 10 per cent of the coal can be saved in almost any steam plant by the application of the bonus system. In plants under his direction daily measurements are made of carbon in the ashes, water fed to the boilers, and carbonic acid in the flue gases, upon which to base estimates of the efficiency of the power house employes.

## Illogical Methods of Determining the Qualities Essential for Success in Engineering

If any proof were needed that engineers should study logic it could be found in the credulity with which so many engineers read articles on character study. Among the most widely advertised "experts" in the psychology of character is Dr. Katherine M. Blackford. Listen to the following from her pen on "Analyzing Character."

> [illegible] He [illegible] And there is no reason why he should not know.
>
> [illegible] much concentration and accuracy. Practically all successful engineers have the practical, scientific type of forehead. By this we mean the forehead which is prominent at the brows and, while high, slopes backward from the brows.
>
> Usually those succeed best in engineering who are medium in texture. The fine-textured individual, however, if he is qualified for engineering, will take up some of the finer, higher grades of it and make fine and delicate material or machinery, or will engage in some form of engineering which requires only intellectual work. Practically all successful engineers are of the bony and muscular type, or some modification of this type. This is the type which naturally takes interest in construction, in machinery, and in material and in material accomplishment. Engineering practice usually requires painstaking accuracy and exactitude. Indeed, this is perhaps more than any other one qualification fundamental for success in engineering.
>
> This, then, in the composite photograph of the successful professional man: He is more mental than physical; more scientific, philosophical, humanitarian, and idealistic than commercial; more social and friendly than exclusive and reserved; more ambitious for professional high standing or achievement than for wealth and power. Unless the aspirant to professional honors has some or all of these qualifications in a considerable degree, [illegible]

We are reminded by this talk of the days when the phrenologist was abroad in the land and the palmist was advertising her powers.

Behold Dr. Katherine deftly twisting phrenology and palmistry into "practical psychology" and "character analysis." All she needs do is change the names of those circus side-show professions, and leaden nonsense is transmuted into golden science.

In his "Talks to Teachers on Psychology" the late Prof. William James pointed out the fallacy of attempting to judge the mental capacity and the "native aptitude" of students by application of a few psychological tests. In fact he questioned the ability of anyone to judge mental efficiency by anything short of actual performance following long training. When the most eminent psychologist that America has produced expresses opinions of this sort, we may be fairly certain that the hypothetical deductions of such writers as Dr. Blackford are untrustworthy. Also note particularly that such hypothetical deductions are never proved by careful observations and experimental tests. For example, Dr. Blackford says: "Practically all successful engineers are of the bony and muscular type, or some modification of this type." She has evidently deduced this conclusion from the hypothetical premise that strong men are instinctively interested in power of all kinds. She makes no attempt to investigate the physical characteristics of, say, 1,000 successful engineers and contrast them with the physical characteristics of 1,000 unsuccessful engineers. That would involve a laborious, scientific study of individual instances upon which to base an induction. Instead, she adopts the very easy process of assuming an induction, and thence deriving a deduced inference, namely, that practically all successful engineers are bony and muscular. Doubtless if it were shown that the majority of engineers are neither unusually bony nor muscular, she would reply: "I didn't say how bony or how muscular, did I? Haven't they all got bones and muscles?" Such are the methods of hypothetical reasoners who shun experimental proofs. They do not even define their principle terms so that they can be held to a strict accountability. Note, for example, Dr. Blackford's term "medium in texture." It may mean anything or nothing, as applied to a human being.

In his excellent little monograph on "How to Study," Prof. Swain urges all engineers to study logic. Yet in the great library of the four largest national socities of engineers there was not a single book on logic when the editor last looked at its list of books. The "science of sciences" sadly needs study by scientific men.

## "20,000 Positions Held by Unqualified Politicians Which Should Be Filled by Engineers"

In an interesting folder issued by the American Association of Engineers, among the questions and answers as to the activities of the association is the following:

> Question—Is not legislation for the benefit of engineers class legislation?
>
> [illegible] argument. Practically all legislation benefits one class or another. Engineers, as a class, have been so long neglected in legislation that it is time for them to receive justice. There are 20,000 positions in the state and federal governments held by unqualified politicians which should be filled by engineers. When [illegible]

This is excellent, and particular emphasis should be placed on the last sentence. There is an inevitable tendency to suspect the motives of any class of men who seek legislation favorable to themselves. Hence great pains should be taken to show that so-called class legislation is beneficial to the entire public. Thus if doctors were to seek legislation to prohibit lying advertisements of patent medicines, there would be some people who would attribute their activity entirely to a desire to create a greater demand for the services of physicians. To overcome such a feeling it would be necessary to prove the prevalent ill effects of dosing with patent medicines. Once that had been established, the public would pay very little attention to the incidental gain to physicians as a result of prohibiting misleading advertisements of medicines.

Similarly engineers should show to the public the efficiency of scientific management and of applied science in general. Then they should contrast that efficiency with the prevalent inefficiency of the ordinary office holder. Having aroused the public to an appreciation of science intelligently applied to public affairs, the public may be relied upon to have enough common sense not to reject the services of engineers nor to oppose any law that makes it compulsory to employ a trained engineer where scientific knowledge can be advantageously applied.

## The Oregon Society of Engineers—Its Aims

The Oregon Society of Engineers includes in its membership all branches of the engineering profession. It is among the most progressive of engineering societies. Therefore the following statement of its aims should be particularly interesting and significant:

> Its aims are to raise the standard of engineering service in both public and private work, and to awaken the appreciation of the public for engineers as executives, economists and leaders, a profession as essential in peace as in war.

This is a concise statement of what should now be the leading object of every general engineering society in America.

## Suggestions for Filing Clippings from Engineering and Contracting

To the Editor: The suggestions by Mr. Hopkins of Rochester in your issue of Aug. 14 as to the makeup of Engineering and Contracting are admirable. To then I would add another; i. e., that the left-hand pages be given advertisements, thus pleasing both advertisers and subscribers and covering his point.

The Dewey decimal classification is so generally used by libraries, engineers and others that printing the appropriate Dewey number at the beginning of the several articles would be well worth while.

I have tried filing the complete journals and indexing on cards the articles, using the Dewey system, but the numbers bulk so rapidly that the plan is too burdensome.

Considerable data comes in the form of letters and circulars the standard size for which is $8\frac{1}{2}$ by 11 in. Using paper of the same size for clippings and cross references works well in vertical files or tied.

There is call for economy in paper. The sheets for clippings can be had from the grist of letters and circulars that go daily into the waste basket. As the mail is opened a pencil mark across the face of the discarded sheets sends them to a drawer that holds the clipping backs.

For one, I would be glad to see the latest Dewey classification of water works engineering subjects printed in your columns for discussion and elaboration.

William A. Wilcox.

Waterloo, N. Y.

**Cleveland May Purchase Telephone System.**—The City Council is considering submitting to the voters at the fall election a $7,000,000 bond issue for purchasing one of the telephone systems now operating in that city.

Newkirk, Okla., has adopted the City Manager Plan and the election for Commissioners will be held Sept. 28.

## Wiped and Flanged Joints for Lead Pipe Connections in Services

For some time the city of Minneapolis has given consideration to the matter of service leaks that occur between the water main and the meter of the consumer. The loss from this leakage has been variously estimated at from 15,000,000 to 20,000,000 gal. per year. A study was made by the Water Department to discover the precise nature of existing troubles so that the proper remedy could be applied on future installations. The results of this study, together with a description of a type of connection superior to the wiped joint were outlined by Mr. J. A. Jensen, Supervisor of the Water Department, in a paper presented at the St. Louis convention of the American Water Works Association. An abstract of the paper follows:

At present the service connections are made up of a corporation cock at the main, and a tail piece with wiped joint to lead pipe leading to the stop cock at the curb where it is again wiped to a soldering nipple. From this point to the meter, galvanized iron pipe is used. All of the wiped joints are made by licensed plumbers who install all services under city inspection. A classification of service leaks was made and some interesting data has been obtained which indicate clearly the various kinds of trouble encountered. The classification was as follows:

| | | | Per cent |
|---|---|---|---|
| 1. | Defective curb cock | 6 | 1.0 |
| 2. | Iron pipe, corroded | 302 | 47.0 |
| 3. | Lead pipe, corroded or burst | 96 | 15.0 |
| 4. | Wiped lead joints | 238 | 37.0 |
| | Total | 642 | 100.0 |

In considering only the serious leaks in this table, those that occur in iron pipe might be set aside, since such pipes are accessible for repairs without disturbing walks or pavements to any serious extent. The portion of the service that should be most secure and durable is the lead pipe and its connections which are located under the roadway and in the majority of cases—under pavements. The street leaks may then be separated and reclassified as follows:

| | | | Per cent |
|---|---|---|---|
| 1. | Defective curb cock | 6 | 2.0 |
| 2. | Lead pipe, corroded or burst | 96 | 28.0 |
| 3. | Wiped lead joints | 238 | 70.0 |
| | Total | 340 | 100.0 |

**Apparent Facts in Street Leaks.**—An examination of these street leaks shows the following facts to be apparent:

The curb cocks enumerated were found to be defective. They were all old-style cocks which have since been replaced by an improved type by the use of which a minimum amount of trouble will be experienced in the future.

The table shows 28 per cent of street leaks to be in the lead pipe itself. About one-sixth of these were due to bursts by swelling of the pipe from repeated water hammer caused by defective faucets. Inspection of these showed all such pipe to be of lighter weight than that used at present. One-fourth of lead pipe troubles were found under car tracks and the pitting and corrosion clearly indicate electrolysis. The remaining leaks were due to other causes though many of them also appear to be from the effects of electrolytic action. Since heavy lead pipe is now used and means are employed to eliminate electrolysis these troubles are already reduced to a minimum, so far as the future is concerned, and justification found for the continued use of lead pipe.

**Trouble Experienced with Wiped Joines.**—The wiped joint leaks made up 70 per cent of the street leaks and troubles. These leaks are due chiefly to inferior workmanship. In most cases there has been failure to secure proper bonding in the joint. A number were "lop-sided", others barely covered the end of the tail piece and in several cases the solder had run inside and partially closed the water opening. One joint had an opening left no larger than a pencil and after a remarkable record of patience covering a period of 24 years, the owner had the service dug up and the trouble was discovered and corrected. Many of the these joints stood up for many years, but finally gave way prematurely.

Several years ago lead pipe was used extensively in all plumbing appliances and fittings made of other materials than lead so that the art of wiping lead joints has passed into the hands of pipe fitters rather than the plumbers of former days. In many shops the wiped joints on service pipes form the only work of this nature that is encountered and it must be undertaken as a special task. The work is attempted by unqualified and incompetent persons not familiar with, nor skilled in the art. The result is that present-day wiped joints, under these conditions, do not measure up to the standard of former times, and more trouble may be expected in the future than in the past if such joints continue to be installed.

**A Mechanical Connection Superior to the Wiped Joint.**—Efforts to secure protection against joints have resulted in the development of a connection that is superior to the wiped joint. This joint is a mechanical connection in the form of a coupling in which the lead pipe is shaped to form its own gasket. The lead flange should undergo slight reaming to make true parallel surface for close contact. The couplings should have plane faces, at least in part, to insure a good joint, and must not be permitted to cut the lead flange. The coupling should have a sleeve to cover a short portion of the lead pipe close up to the flange to prevent any movement or deformation of the lead to the joint. The shaping of the lead flange may be conical or at right angles to the axis of the pipe. There are several types of this joint on the market, all having desirable features of design, but the principle is similar in all cases. The coupling is made a part of the corporation or curb cock and is of composition metal. The joint develops the fullest strength of the lead pipe and is equally as strong as the best wiped joint and superior to it in results because it can eliminate defective workmanship. Tests made in the presence of water works men have demonstrated conclusively that rupturing stresses applied as internal pressures and tension on lead pipe secured at both ends by flanged curb cocks, have failed to break the joint or injure the coupling. In all cases the lead pipe burst or parted.

**Comparative Cost of Wiped and Flanged Joints.**—The initial cost of the material for this joint is slightly greater than for the wiped joint, but when the necessary labor is added, this cost is more than offset. The cost to the property owner ought at least to be practically the same. An intelligent man can make a flange coupling joint with simple tools and a pair of wrenches in a very short time, and on the ground where required. The comparative cost of the wiped joints and flange couplings in an ordinary service, at recent prices and labor costs, is as follows:

| | |
|---|---|
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |

This shows a balance of $0.50 on each service in favor of the flanged joints which can be considered as a margin for fluctuation in cost of materials and labor.

**Longer Life of Service Connections with Flanged Joint.**—In considering the data given, the use of lead flange joints promises longer life to service connections as a whole, and a consequent reduction of leakage troubles and expense to both the city and property owner. The street service department of Minneapolis has used lead flange couplings of different types for repair work for several years and they have been satisfactory and successful in every way. They have not only proven more convenient than the wiped joint for the department, but their use has also resulted in the saving of time and money in every case.

## Electric Companies Effect Economies by Delivering Bills in Person

The Indiana Railways & Light Co., by having its metermen deliver electric light bills, is saving approximately $1,000 per year. Before the war the company was mailing its bills at a cost of $11 per 1,000. This includes postal cards and printing. It is today delivering in person at a cost of $10.60 per 1,000, including paper stock, printing and labor. Had it continued to send the statements out by mail the cost would be $21 per 1,000. The labor item figures 0.74 ct. per statement delivered.

Further information regarding the practice of Indiana electric light companies is given in the Electrical World by Mr. O. M Barser. Questionnaires were forwarded to 48 leading member companies of the Indiana Electric Light Association, representing 56 different properties. Twenty-eight replies, representing 39 properties, were received. The first question was, "Do you deliver by mail, in person, or are bills held at office?" There were 34 replies, divided as follows: By person, 15; by mail, 8; bills held at office, 11. One reported that bills were made out and left by readers. Question number two asked for the cost per statement delivered by person. There were 12 answers. The average was 0.89 ct. each. Question number three asked, "Do you have many complaints from customers where bills are delivered in person?" All answered, "A few." In seven cases the meter readers did the delivering, in two cases office clerks, in two cases young boys, and in one case an office girl. It is of interest to note that where boys were used the cost per statement averaged only 0.49 ct. each.

**Cost of Meter Installation at Chicago.**—During 1917 the water meter shops division of the Department of Public Works of Chicago installed 2,198 new meters, of which 2,104 were city owned and 94 private meters. The average cost of installation for the former was as follows:

| | [illegible] |
|---|---|
| [illegible] | [illegible] |
| Material | 2.71 |
| Labor | 3.67 |
| Total | [illegible] |

Of the 2,198 meters, 100 were ¾ in., 1,033 1 in., 602 1½ in. and 342 2 in.

# The Development of Water Supplies for Rural Communities in Saskatchewan*

By E. L. MILES,

Inspecting Engineer, Irrigation Branch Department of Interior, Canada.

Generally speaking, small towns and villages are in a primitive state as regards their water supplies. In some cases water is hauled from neighboring springs and sold to the residents in pails or by the barrel. This, however, is due to the lack of funds which might better the conditions. In other cases the town pump is in evidence at the principal street corner. The larger towns have their own systems.

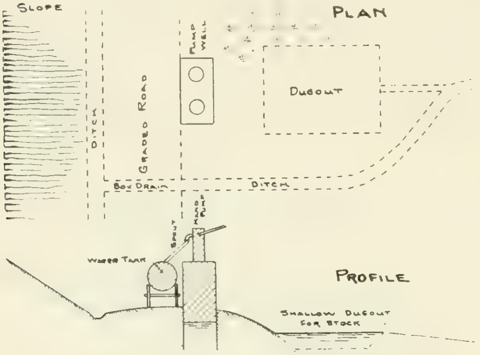


Fig. 1—General Layout for Development of Community Springs.

**Supply from Springs.**—The spring is, of course, the most sought after source of water supply in the dry districts. The development of springs depends largely upon conditions, but for rural communities the general rules are as follows: first, to establish a graded road to and from the site, next to construct a box to which a pumping appliance can be installed, and next, the excavation of a reservoir for the use of stock. Figure 1 shows the general layout for development of community springs.

**Reservoirs.**—This is, indeed, the most interesting type of water supply development from an engineering standpoint, inasmuch as the construction of the dam requires considerable engineering judgment, especially in view of the fact that stone and concrete are not always available in these dry districts. The best and most efficient reservoirs which have come under my observation is the combined reservoir and dugout in narrow coulees, say, up to a depth of about 50 ft., where the supply is more readily replenished from the larger drainage basin or watershed and the reservoir is protected from hot winds, etc. They are less susceptible to flooding, and depth of water is obtained by means of a dugout. The dam is usually low, and the spillway problem is therefore more readily solved. The spillway capacity is invariably under estimated; that is, they are built for normal conditions rather than extreme flood conditions. The extreme floods occur about once every seven years and when they do occur, it is common to find about 75 per cent of the dams washed out. I am a strong advocate of placing the spillway always at the side of the dam in the natural ground, rather than in the center, even though the spillway be constructed on piles, as I sometimes find them.

Community dams are usually built on road allowances, the top being used as roadways. This has been disputed as "good practice," but I am personally in favor of it, especially on account of having the water convenient to the highway, and the fact that the work is not duplicated. The inconvenience to travel by reason of washouts occurs in any case, and we are living in hopes that the day will soon come when these yearly washouts will be stopped by better engineering construction, even though it means greater initial cost in the first place.

A brief form of instructions for the construction of a dam aside from the general specifications as to dimensions and slopes, might be cited as follows:

**Instructions for Construction of Dams.**—On commencing the construction of a dam it is important that the site be entirely stripped of all sod and vegetable matter, and that same be removed to a convenient point, to be used after to sod down the top and lower slope, on completion of the work. The ground thus stripped should have furrows ploughed every 4 or 5 ft., at right angles to the coulee, in order to give a rough surface to the ground to resist seepage. The puddled wall trench should then be dug to a depth well below the top soil or loam, into an impervious strata and the trench re-backfilled with a selected clay, and well puddled with water. When this trench is filled the main portion of the dam should be commenced, and the material used should be a suitable clay, free of vegetable matter and stones. The borrow pits which should be located on each side of the dam on the upper side, should therefore be stripped of both sod and top soil. The material should be spread in thin layers, and well consolidated by tramping, but special runways should be avoided. It also is important that the sides be carried up considerably faster than the center, and that the center immediately over the puddle wall be continued up into the embankment for at least 3½ ft.

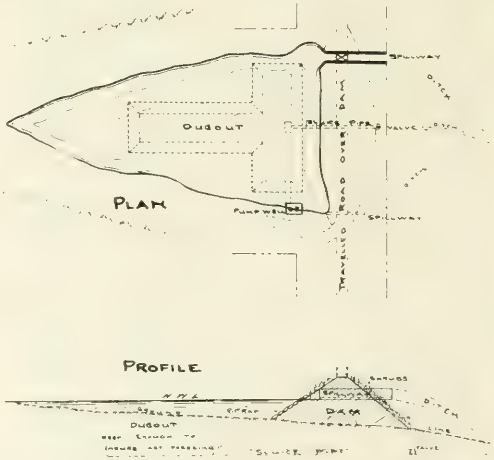


Fig. 2—General Layout for Community Reservoirs in Coulees.

On completion of the earthwork, cobblestone riprap should be placed on the entire upper slope to assist the clay to maintain its slope, as well as to prevent wave wash from wind. If cobblestones are not available, lumber is sometimes used for this purpose, in the form of an ordinary board fence constructed on the slope. Shrubs are often planted from the water line to the top on the upper and on the entire lower slope. The balance of the earthwork should then be seeded down, after the available sods from stripping have been placed.

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*Abstract of a paper presented Aug. 8 at the Second General Professional Meeting of the Engineering Institute of Canada.

The spillway must take care of the entire runoff after the dam has been filled, and in no case is any water to be permitted to go over the top of the dam. If the owner can afford this expense, the spillway should be paved with concrete or hand-placed riprap for a distance of about 20 ft. on each side of the center line of the dam, and the paved portion should be level so that the current in it will be reduced as much as possible. After leaving this portion, care should be taken to ditch the water away from the embankment, and the ditch should be well riprapped to prevent erosion.

After completion, the embankment should be inspected from time to time and any defects, such as settlements, rain wash, wear from stock tramping, or damage from burrowing animals, should be repaired.

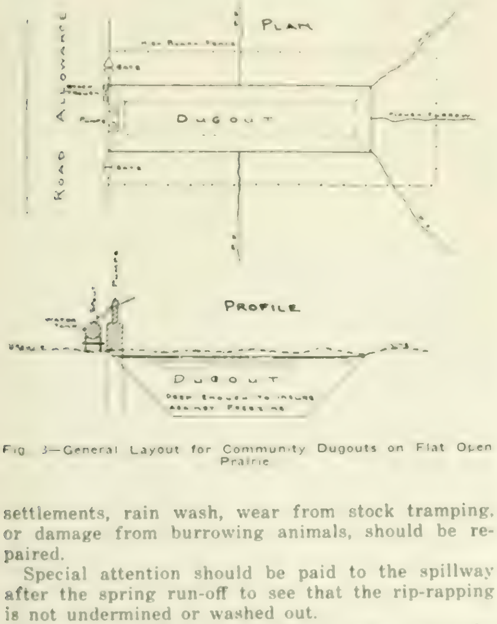

Fig. 3—General Layout for Community Dugouts on Flat Open Prairie

Special attention should be paid to the spillway after the spring run-off to see that the rip-rapping is not undermined or washed out.

Reservoirs of the type outlined above with the spillways at or above the high water line are of course difficult to clean, but they are built nowadays in this manner as a matter of economy. Sluice pipes equipped with valves, or concrete spillways equipped with stop logs or gates would, of course, make them more complete.

In some private scheme I have found some very unique forms of construction, especially where people from foreign lands have constructed the dams. One form is to build a rustic fence of poles, interlaced in a strong manner, and then covered with the earthwork, having the fence sticking up through the upper slope at the high water line. Sometimes this fence is seen on the lower slope, and where this type is used the dams are usually intact, while others nearby have been washed out of existence. Figure 2 shows a general layout for community reservoirs in coulees.

**Dugout Type of Reservoir.** The most peculiar form of reservoir is the dugout located on the flat open prairie in heavy gumbo soil. These dugouts are generally about 200 ft. long by 50 ft. wide and from 10 to 15 ft. deep, with sloping sides, holding about 700,000 gal. of water. They are equipped with pumping appliances for the taking of water, and fenced with high board fences to protect them from pollution. They are rather popular, as the water does not deteriorate very rapidly, on account of the depth and the minimum surface area. Plant life is also kept down, and the cost of construction and maintenance is comparatively low. Dugouts are sometimes located in dry slough beds, on account of the impervious soil and because of the natural location for replenishment. But this is not a desirable location, because of the quality of water in them. It is usually high in color from decayed vegetation, and therefore more infested with insects.

A dugout of this kind will serve an area of about 9 square miles, based on the following estimate. The average farm in the grain district is about ½ section or 320 acres of land, each farmer supporting about 6 persons, 10 horses, 10 cows, and 10 hogs, which will consume about 600 gal. of water per diem, or a little less. So that the estimated water supply for each township would be about 43,000 gal. per day, at all times, or about 72,000 gal. per day in the threshing season, considering that only about one-quarter of the farmers of the township are actually threshing at the same time. The standard dugout of about 700,000 gal. capacity, with four to each township, in addition to the usual private means of water supply, will give a full 40 days' supply, which is generally the length of the brisk threshing season for which these 40 days are considered.

Figure 3 shows the general layout for community dugouts on flat open praire.

## Cost of Sinking Test-Pit Through Sand and Water

During the construction of a very deep sewer a test-pit was sunk by hand to the invert, in order to determine the character of the ground. The hole was 24 ft. deep and 8 ft. square. The top 3 ft. consisted of coarse sand and the balance of the hole of sand surcharged with water which increased in quantity, until near the bottom, the soil resembled quick-sand although not as difficult to handle.

The top 12 ft. were braced with the usual close lagging and cross bracing, and the bottom 12 ft. were close sheeted. The earth was lifted in a bucket operated by a windless. The workmen digging also looked after the timbering, assisted by the men operating the windlass. An Edson hand pump was kept in operation night and day. The labor costs could not be separated, but the total came to 296 hours, exclusive of back-fill and the removal of some timber, which took an additional 66 hours. The work was done with good Italian labor.

The total cost of labor follows:

| | |
|---|---|
| [illegible] | [illegible] |
| | [illegible] |
| [illegible] | [illegible] |
| Cost per cubic yard of back-fill . | [illegible] |

# Leakage from High Pressure Mains and Its Variation with the Pressure

For many years waterworks officials have discussed leakage from distribution systems and the effect of changes in pressure without being able to come to definite conclusions, due to the fact that, except that for single supply lines laid generally under most favorable conditions, after the main has been placed in service it has been impossible to separate leakage from consumption. Interesting data on this subject, obtained from tests of the high pressure fire system of Manhattan Borough, New York City, are given by Mr. Henry B. Machen, in the Journal of the American Waterworks Association, from which the matter following is abstracted:

The high pressure fire system in the Borough of Manhattan, New York City, due to the fact that New York has not permitted any private connection to its fire mains, gives an opportunity to make tests on a distribution system of 128 miles of mains, 2,728 hydrants and over 4,748 valves covering an area of 3,675 acres. The system has received during its 10 years' life most trying tests. Each year it has had the pressure raised from, say, 35 lb. to from 125 to 250 lb., an average of over 2,000 times a year, due to fire alarms within the district, and for each period of 12 hours in duration which no fire alarm has sounded the pressure has been raised for one-half hour to 200 lb. for testing out. It is hard to believe that any other water system in the world has gone through similar service conditions. The system includes the following pieces:

| | Number. | Per cent. |
|---|---|---|
| Pipe, full lengths, 8 in. to 24 in. | 44,134 | 54.4 |
| Bends and offsets | 10,834 | 13.3 |
| 3-ways, 4-ways | 4,279 | 5.3 |
| Short pieces | 21,950 | 27.0 |
| Total | 81,197 | 100.0 |

The mains were all laid in the lower portion of Manhattan Island, where subsurface conditions are most congested. This subsurface congestion shows readily in the figures given in the table by the large number of bends and short pieces of pipe used, even after the city had availed itself of its right to order moved gas mains and other interfering subsurface structures.

After the mains were laid they were subjected to an acceptance test of 450 lb. for a period of 10 minutes for the earlier contracts and for 20 minutes for the later ones, the leakage being measured and for acceptance had to come within the limit of 4 gal. per linear foot of pipe joint per 24 hours.

In testing, the test sections were in all cases between valves and doubtless a portion of the loss was due to water passing the valves limiting the section under test.

The mains were limited in the acceptance test of 450 lb. per square inch to a leakage at the rate of about 800 gal. per minute for the entire 128 miles. The actual gross leakage of all the tests was 452 gal. per minute. Today there is a leakage, as shown on the Venturi meters, of 950 gal. per minute at an average pressure of 33 lb.

Investigations have been made to locate the leaks, but due to lack of force the work has not been systematically carried on. However, due to the wide range in pressure, property owners have themselves reported eight connections which had been placed evidently by mistake. There may be others not placed by mistake in which advantage is taken of the higher pressure available at times to fill tanks. The occasional erratic movement of the pen in the Venturi chart may be an indication of this.

An aquaphone test of each hydrant made by a most careful and competent inspector who covered every one of the 2,728 hydrants showed but 51 (1.9 per cent) on which any sound could be detected, indicating leakage which could not be stopped by tightening the valves.

Of course, it might be said that a certain number of hydrants might be not tightly closed at all times in such a large number, but the system of maintenance is such that each hydrant is examined and repaired if necessary immediately after going out of service at a fire by an experienced machinist who reports to a follow-up system that the hydrant has been examined by him and left in good condition. The firemen, after an alarm, are the only users of the hydrants. Should any one else open a hydrant it is immediately known by an alarm bell operated by the Venturi meter recorder on the priming line.

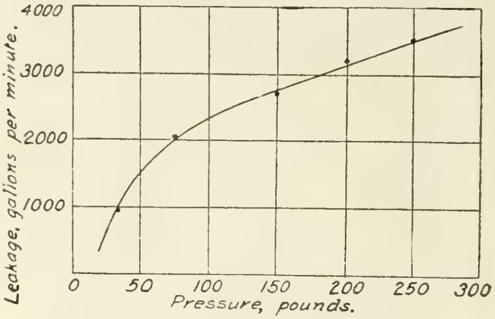

Fig. 1—Results of Test Under Varying Pressure.

During the past 6 years many miles of streets have been opened for the construction of the rapid transit subways, exposing over 54,000 lin. ft. of the high-pressure mains. No leakage has been found in the joints except an occasional sweat and from this evidence the Bureau of Water Supply is inclined to believe that the loss of water is not at the joints.

Fig. 1 gives the result of a test under varying pressure made on Dec. 8, 1916. Attention is called to the almost straight line of the upper portion of the curve, which seems to indicate that the leakage is not from fixed openings, from which a leakage varying as the square of the pressure should be expected.

It may be that the symmetrical results obtained and shown on the curve are but accidental; that as the pressure increased the main valves of the hydrants, which close under pressure, closed more tightly, reducing the leakage in the hydrant; that at the same time stuffing boxes in valves which are tight under low pressure might leak under the higher; that cracks in the pipe or steel casting not open under low pressure open under the higher.

**Underground Leakage in Water Pipe System of Chicago.**—The matter of investigating and remedying underground leakage in the water mains and service pipes of Chicago was prosecuted diligently during 1917, resulting, states Mr. John C. Ericson, City Engineer, in his annual report, in the information that the underground leakage is not probably more than 6 per cent of the entire pumpage.

# Design and Operation of Sewage Treatment Plants with Special Reference to Minnesota Conditions*

By H. A. WHITTAKER,
Director of Sanitation, State Board of Health, Minnesota.

Before designing a treatment plant, a careful study should be made to determine the volume and character of sewage to be treated. When the sewers are already in use, actual measurements of the sewage flow should be made, covering a considerable period. A census of the actual number of sewer connections should be taken and a record made of the character and amount of sewage discharged from manufacturing plants, such as creameries, tanneries, gas plants, etc. The ground water flow should be measured or carefully estimated. The plant should be designed in accordance with the above data and with reasonable allowance for future growth.

Where a new sewerage system is to be constructed, care should be taken to obtain good grades, whenever possible. Flush tanks should be installed wherever the grade of the sewer is such that it will not be self-cleansing at all times. The sewerage system should be so designed that the sewage will be delivered to the treatment plant in as fresh a condition as possible.

For small plants, where the sewerage system is of the separate type, removing house sewage only, grit and screen chambers may often be omitted to advantage. Grit and screen chambers are necessary where the sewerage system is of the combined type, and, when used, these chambers should be made easily accessible for cleaning.

**Imhoff Tanks.**—The settling chambers should be designed to hold the average flow of sewage for a period of two hours. The sloping walls of the settling chamber should be constructed as steep as possible; never less than 1.2 vertical to 1.0 horizontal, and, better still, 1.5 vertical to 1.0 horizontal. The walls should be smooth, with no projections. A baffle should be installed at the inlet and a scum board at the outlet. These should be located approximately 1 to 2 ft. from the inlet and outlet ends of the tank, respectively. They should extend across the tank and to a depth of about 12 in. below the surface of the sewage. The invert of the inlet pipe or pipes should be at an elevation of a few inches above the surface of the sewage. The inlets and outlets should be so located as to distribute the flow as much as possible across the entire section of the settling chamber. Outlet weirs should be relatively narrow. Very wide weirs are not desirable, since it is difficult to keep them clean.

The sludge compartment should be of generous size. For Minnesota conditions, where the winters are long and severe, a part of the sludge must remain in the tank for nearly a year. It is the opinion of the Division of Sanitation of the Minnesota State Board of Health that sludge compartments should have a capacity of at least 2 cu. ft. per capita. In computing the size of the sludge compartment, only that portion should be considered that is below a horizontal plane 2 ft. below the slot or slots in the bottom of the settling chamber. The sludge will not flow a great distance horizontally to the sludge removal pipe. In large tanks, two or more sludge removal pipes should be provided.

Tanks should be uncovered. Light, easily handled, wooden covers should be provided for winter use. The entire plant should be surrounded by a tight, high ornamental fence, to keep out animals and unauthorized persons.

The operation of a sewage treatment plant is a very important feature and one which is seldom given sufficient attention. A poorly designed plant under conscientious management will often produce better results than a well designed plant with indifferent management. Plants should be constructed so that all parts are easily accessible to the operator. It is frequently necessary to break up the scum which will collect on the sewage in the vents and to scrape down the walls of the settling chamber and push through the slots material which will adhere to the walls. Readings should be taken frequently to determine the surface of the sludge in the sludge chamber so as to know when and how much to remove. The sludge should be examined occasionally to determine whether or not it is acid or alkaline. An acid sludge is sour and foul-smelling and generally requires a long period for drying. Such a sludge should be treated with lime.

The operator should be provided with necessary tools and apparatus to care for his plant. The tools usually consist of a sludge scraper, used for the purpose of scraping down the walls of the settling chamber; a scum breaker, used for the purpose of breaking up the scum which may collect on the surface of the sewage in the vents; a skimmer, used for the purpose of removing to the vents scum which sometimes collects on the sewage in the settling chamber; and a sludge sampling apparatus, in order to determine the position of the surface of the sludge, and a set of Imhoff tubes with which the operator can determine roughly how the plant is operating. Each plant should be provided with a house of generous size in which the tools can be kept and in which the necessary analytical work can be performed.

**Pumping Machinery.**—Where it is necessary to pump the sewage or the sludge by pumps driven by electric motors, the motors, switch boards, or starting rheostats should be located in a building not directly connected with any part of the sewage treatment plant, since the condensation and moisture in the winter months is very heavy on all parts of the plant directly connected with the settling or vent chambers.

**Sludge-Drying Beds.**—Sludge-drying beds should be located as close as possible to the Imhoff tank. Where it is necessary to conduct the sludge a distance of 10 or 15 ft. horizontally to the drying bed, it should be allowed to flow in open channels rather than in pipes, since long sludge pipes are likely to become clogged with dried sludge. Where the sludge is removed from the tank by gravity, the sludge pipe outlet should be at an elevation at least 6 ft. below the sewage in the tank. The sludge should be discharged on to the bed from an elevation at least 2 ft. above the surface of the bed so that the sludge removal pipe can be drained after each removal of sludge. The sludge drying beds should be of generous size, having an area of not less than 1 sq. ft. per capita.

**Percolating Filters.**—Percolating filters, where necessary, should be of ample size, so as to prevent overworking. It should be remembered that in the colder climates the bacterial action in the filters is much slower than in milder climates. Therefore, to produce the same results, filters must be considerably larger than would be necessary in a southern climate. Certain tests at Milwaukee, Wis., indicated that, on very hot days, percolating filters could be operated efficiently at the rate of 4,000,000 gal. per acre per day, whereas, in colder weather, only 400,000 gal. per acre per day could be applied to obtain the same results. The Division of Sanitation recommends that percolating filters in Minnesota be designed to operate at a rate of 1,200,000 gal. per acre per day, where the average depth of stone is at least 6 ft.

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*From a report to the Minnesota State Board of Health.

**Resettling Tanks.**—A resettling tank, having an average holding period of about one hour, shall be installed wherever percolating filters are used. This tank shall be provided with cross baffles. The bottom shall be hopper-shaped. Adequate provision for sludge removal shall be provided. The sludge-drying bed shall be constructed in a manner similar to the bed for drying the sludge from Imhoff tanks. This bed shall have a net area equal to at least ½ sq. ft. per capita.

**Sand Filters.**—Sand Filters have not been entirely successful under Minnesota conditions, due to freezing in cold weather. They cannot be operated at rates much exceeding 100,000 gal. per acre, per day, and requires a great deal of attention.

**Rules for Operation of Imhoff Tanks.**—Any material, other than sand and grit, which may collect in the inlet chamber, should be forced through the opening into the settling chamber. Sand and grit should be removed and deposited upon the surface of the ground. The inlet chamber should be kept clean at all times. Any material which rises to the surface of the sewage in the settling chamber which does not sink readily when broken up should be removed to the vents. Any sludge which deposits on the walls of the settling chamber should be forced through the slots into the sludge-chamber. The walls of this chamber can be kept clean by daily scraping and forcing any adhering deposit through the slots.

Any scum which collects on the surface of the sewage in the vents should be thoroughly stirred up daily, so as to liberate the entrained gases and facilitate the settling of the solid material. If the scum in the vents should reach a thickness of over 6 in., a portion of it should be removed. The surface of the sludge in the sludge chamber should never be allowed to reach a point higher than 2 ft. below the slots, equivalent to a point about 9 ft. below the surface of the sewage. The level of the sludge in the sludge chamber should be lowered about 2 ft. each time the sludge is removed, except in the late fall, when about 4 ft. should be removed to allow for the winter's accumulation. The operator should be provided with a sampling outfit by means of which bottle samples of sewage in the sludge chamber can be collected at various depths and the exact location of the surface of the sludge determined.

The surface of the sludge should be determined at least once every two weeks.

Ice which may collect on the surface of the sewage in the settling and vent chambers should be removed immediately.

When the sludge on the drying bed reaches a depth of about 1 ft., it should be removed. Since a portion of the sand will adhere to the sludge removed from the bed, it will be necessary to replace the top layer of sand on the bed from time to time.

# Loss of Head in Corporation Cocks and Service Pipes

Several years ago a series of tests were made by the Bureau of Investigation and Design of the Department of Water Supply, Gas and Electricity, New York City, to determine the losses of head in corporation cocks and service pipes. The results of these tests are summarized by Mr. B. J. Bleisteine of the Department in a paper presented before the American Waterworks Association. The matter following is abstracted from the paper:

All sizes in use by the department at that time were tested. Of the two largest sizes, four of each type were tested, and of the smaller sizes, two of each type. Of the lead and galvanized service pipes, four lengths of each size about 15 ft. long were tested.

The observations were very carefully made, the losses being measured by mercury deflections, and the discharges by a 2-in. meter of the current type. In taking the readings three observers were used, one to read the meter, the others to note the U-tube deflections. At each rate of flow a sufficient quantity of water was allowed to pass so that the dial hand on the meter made a complete revolution. In this way any errors due to eccentricities of the dial hand or inaccuracies in the gradations were eliminated. The time was taken with an ordinary watch, readings being taken to the nearest half second. As the total time for any individual test was never less than 2 minutes, the resulting error was probably less than 1 per cent. The deflections were read at 15-second intervals, the readings being taken to the nearest 1/16 in. As no deflection was less than 1 in. and at least eight readings for each rate were taken, the error is probably also well within one per cent. After a sufficient number of tests had been made on each length, the unit losses at the observed rates of flow were computed, 1 in. of mercury deflection being equivalent to 1.047 ft. of water. These values were substituted in the Williams and Hazen formula, $V = c^1 m^{0.63} s^{0.54}$, and the average value of c for each length obtained. From these the average value of c for each size was computed. The values of c for the same section of pipe at different rates of flow showed very little variation, the extremes varying not more than 3 per cent from the average. For different sections of the same length of pipe, however, the variation was considerable, even in the case of the lead pipe. The ½-in. pipe shows the greatest difference. If the same difference had prevailed in the pipe upon which the loss of head tests were made and the actual diameters had been used in the computations, the effect would have been to reduce the values of c somewhat. In the case of the ½-in. this would have meant a reduction of 4 in. However, as it is usually quite difficult to measure the diameters accurately, values of c computed on the basis of the standard diameters would be of the greatest value.

With one exception, the losses through the cocks with 90-degree tail pieces are larger than those with 45-degree tail pieces, the difference being greater for the smaller sizes. The addition of a strainer or eel guard practically doubles the loss.

The relation between the loss in the corporation cock and the velocity head may be expressed by the formula $C = H/P$, in which H is the velocity head, and P the total loss as measured by the U-tube minus the loss through the 1 ft. of lead pipe. The value of

C is not a constant, being in general higher for the larger values of H. The loss P also represents the pressure required to produce the velocity head H; hence C is equal to the co-efficient of discharge. Table I shows the values of C.

TABLE I.—VALUES OF C.

| Size and kind | [illegible] | [illegible] |
|---|---|---|
| [illegible] | | |
| [illegible] T. P. | [illegible] | [illegible] |
| [illegible] | | |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | | |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | | |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | | |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | | |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | | |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | | |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |

The relation between the losses in the corporation cocks and the losses in pipe can be shown by computing the length of lead pipe of a size corresponding to the size of the cock, in which the loss would be the same. This equivalent length is not a constant, being greater for the higher rates of flow and for the larger cocks. Table II gives the range in the values of this length for the various sizes and rates of flow indicated.

TABLE II.

| Size and kind | [illegible] | [illegible] |
|---|---|---|
| [illegible] | | |
| [illegible] T. P. | [illegible] | [illegible] |
| [illegible] | | |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | | |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | | |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | | |
| 45 degrees | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | | |
| 45 degrees | 30.0—160.0 | 14.10—23.45 |
| [illegible] | [illegible] | [illegible] |
| [illegible] | | |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | | |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |

**Cost of Field Work on Meter Repairs and Replacements at Chicago.**—The water meter shops of the Department of Public Works of Chicago, during 1917 carried out 11,654 field-work jobs in connection with meter repairs and replacements. The average cost per job, according to the last annual report of the Department, was as follows:

| [illegible] | [illegible] jobs. | [illegible] material [illegible] |
|---|---|---|
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| Meter locations changed | 1 | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | 1.76 |
| [illegible] | [illegible] | [illegible] |
| [illegible] | | 15.12 |
| Totals | [illegible] | [illegible] |

## Considerations Affecting the Selections of the Combined or Separate System of Sewers

In its tentative instruction to designers for the sewerage, sewage treatment and drainage of industrial housing development the Engineering Division of the Bureau of Industrial Housing and Transportation of the U. S. Department of Labor summarizes as follows the conditions that should be taken into consideration in selecting the combined system or the separate systems of sewage:

**Conditions Favoring Separate System.**—The separate system of sewers is indicated as most desirable when the following conditions obtain:

Where storm water does not require extensive underground removal or where it can be concentrated in a few shallow underground channels.

Where drainage areas are short and steep, facilitating rapid flow of the water over street surfaces to the natural water courses.

Where the sanitary sewage must be pumped and additional cost of pumping even of a small amount of storm water is great.

Where the sanitary sewage must be purified and storm water is a combined system either purified or by-passed—either scheme requiring large purifications plant capacity or creating nuisance due to the overflow of objectionable refuse.

Where the sewers are being built in advance of a city's development to encourage growth, the separate system often provides a maximum number of miles of sewer for a minimum of expenditure.

The storm sewers if ever required may be gradually introduced later and rarely need to cover over about one-half the area covered by a sanitary system. This consideration, however, is not always applicable to the present intensive and complete housing development schemes.

A combined system of sewers must usually be relatively of larger capacity than a separate storm drain for the same area, because the storm drain may be overloaded at long intervals with slight inconvenience, whereas in a combined sewer any overflow is accompanied by a great nuisance and complaint owing to basement connections and consequent liability of flooding.

In general, rather rough topography with marked natural drainage and open spaced residential settlement not likely in the future to become dense, together with the desirability of sewage treatment indicates the separate system as the method most desirable.

**Conditions Favoring Combined System.**—The conditions that indicate that the combined system is the one most desirable are as follows:

Where it is evident that both storm water drains and sanitary sewers must be fully and completely installed throughout the entire length of the street in the district, it is obvious that the total cost will be far greater for the separate than for the combined system.

Where no pumping or purification is required at present or is anticipated in the future.

In general flat topography without natural drainage and with dense settlement or future liability to dense settlement together with the lack of necessity of sewage treatment indicates the combined system as the method which is desirable.

**Combination of Two Systems.**—The selection of system to be adopted should not follow hard and fast rules. Often in the same development it may be desirable to provide in one part the separate system, in another part the combined system, and still in another part a combination of the two methods. Occasionally a combined sewer may be introduced in a separate system to advantage with interception of its natural flow at some point before the outlet is reached. The economical and efficient method is only arrived at by outline design and cost comparisons of different projects.

**Combined Systems and Treatment Plants Sometimes Warranted.**—It does not always follow that where sewage treatment is involved the selection of the separate system is imperative. It is usually desirable but cases may arise where the combined system should be adopted although sewage treatment in some form is necessary. This latter condition will be the same ordinarily where—

1st. All streets must have storm water removal.

2nd. Where very complete treatment is not necessary.

3rd. Where high grade effluent from the treatment plants is not warranted.

4th. Where storm flows can be safely and properly by-passed into flooded streams.

5th. And in general where cost of treatment works (considering operation as well) for a somewhat large normal flow are obviously less than the cost of duplicate sewers in full throughout the district drained.

## Leaks in Water Mains at Hamilton, Ont., and Cost of Repairs

A large number of leaks developed in the larger size water mains of Hamilton, Ont., during the summer months of 1916, and as a consequence it was necessary to devote the services of one large gang exclusively to these repairs. On the 30-in. mains the trouble was in almost every case blown joints These joints when repaired were reinforced with expanded metal and concrete. Two breaks on 20-in. mains were caused by water hammer and occasioned some extra trouble and expense. On the 36-in. mains only one large repair was made. Repairs on the smaller mains were of the usual character, and were not more numerous than in former years. The numerous leaks on the larger mains were occasioned by disarrangement in the pumping system. The following statement from the last annual report of E. R. Gray, City Engineer, shows the number of leaks and cost of repairs per mile:

| Size, in. | Total mileage. | No. leaks. | Leaks per mile. | Cost of repair per mile. |
|---|---|---|---|---|
| 48 ........ | 0.02 | .. | ................ | $...... |
| 36.. ...... | 2.46 | .. | 1 in 0.41 miles | 230.15 |
| 30. ....... | 6.50 | 5 | 1 in 1.30 miles | 107.98 |
| 24......... | 1.50 | 1 | 1 in 1.50 miles | 9.90 |
| 20.......... | 9.71 | 11 | 1 in 0.88 miles | 76.98 |
| 18.......... | 6.69 | 2 | 1 in 3.348 miles | 73.64 |
| 16.......... | 0.80 | 0 | ................ | ...... |
| 12.......... | 12.71 | 3 | 1 in 4.237 miles | 6.23 |
| 10.......... | 2.54 | [illegible] | 1 in 1.272 miles | 77.93 |
| 8.......... | 3.54 | 0 | ................ | ...... |
| 6.......... | 133.35 | 40 | 1 in 3.333 miles | 5.54 |
| 4.......... | 2.08 | 0 | ................ | ...... |
| 2.......... | 1.32 | 1 | 1 in 1.322 miles | 9.23 |
| 1.......... | 3.72 | 1 | 1 in 3.721 miles | 3.07 |
| Total ...... | 186.98 | 72 | 1 in 2.596 miles | $ 19.06* |

*Average.

**Cost of Meter Readings at Hamilton, Ont.**—The city of Hamilton, Ont., had 636 water meters in service during 1916. The cost of the 7,679 meter readings for the year was $821.70 or 10.7 ct. per reading.

## Malaria Prevention Work at Camp Bowie, Tex.

With the movement of the troops to the Southern cantonment areas last fall, the United States Public Health Service recognized that an emergency existed. Many of the cantonments were in the most heavily infected regions, from a malarial standpoint, that existed in the United States. Plans were at once made by the Service to inaugurate, in connection with the general sanitation of the zones around these camps, a vigorous campaign against the Anopheles mosquito. During the winter surveys were made and all preparations completed for mosquito control work early in the spring. The campaign as carried out at Camp Bowie, near Fort Worth, Tex., was described by W. A. Hardenbergh, Chief Sanitary Engineer, U. S. Public Health Service in "Pass in Review," a newspaper published for the soldiers in training at Texas Camps, from which the following notes have been abstracted.

In April a survey of possible mosquito breeding places in the neighborhood of Camp Bowie and three aviation fields was made, equipment ordered and plans made for the necessary work. These plans for the campaign against the Anopheles mosquito contemplated such work as might be necessary for the destruction of their shelters and breeding places. This is done by draining such pools and swamps as will hold water more than a week or in so cleaning these pools and swamps that there are no places where the larvae may hide from the minnows and other small fish which feed on them. In fact, fish are among the most efficient allies in the fight against the mosquito and fish control is often the easiest, at times the only way.

**Methods of Mosquito Control.**—Where neither draining nor fish control is practicable, it has been found that the application of a thin film of oil to the surface of the water will destroy the wrigglers and tumblers by clogging their breathing tubes. There are, then, three main ways to get rid of the mosquito: By draining away the water, by allowing the fish to get at the larvae and pupae, and by oiling.

Plans for the work at and around Camp Bowie provided for all three methods. It was planned to clean the banks of both forks of the Trinity River near the city and the camp, thus eliminating hiding places for the larvae in the grass and brush along the banks and allowing the fish a chance to feed on them. The estimate called for cleaning 50 miles of river bank. Ditching and draining was contemplated for the sloughs and stagnant pools, while the small streams and branches were to be straightened and cleaned. The estimate on ditching called for about 50 miles of this work. Oiling was relied upon to control mosquito production while ditching and river bank cleaning was in progress.

Work was begun in the second week of May with a single foreman and about a dozen men. More men were added as rapidly as possible and the work attacked from various sides. One gang of men—part of the time two—have been kept steadily at work cleaning the river banks and bringing them to a sharp edge free from grass or other obstructions. In connection with this work, the streams have been cleaned of obstructions and drift that might provide shelter for the larvae. To June 20, approximately 34 miles of this work had been completed.

On the smaller streams which usually offer still more favorable opportunities for breeding than do the larger ones, the character of the work is slightly different. Most of the streams around Camp Bowie are composed of grass or weed-bordered pools, with a more or less steady flow of water between. These grassy edges offer ideal places for the growth of mosquitoes. The method of procedure here has been to lower the pools by connecting ditches, which drains them down so that the mud banks offer no protection from the fish. The channels where water is flowing, are cleaned and straightened, grass and weeds cut and obstructions removed. This removes the breeding places and at the same time destroys the daytime roosts.

**Destruction of Breeding Places in Shallow Depressions.**—In the outskirts of the city of Fort Worth there are quite a number of sloughs or shallow depressions holding water. These have, in the most cases, been caused by borrow pits for road fills, levees and railroads, or by the cutting off of a natural drainage course in levee or similar construction. These are among the most prolific breeding places locally. The general plan has been to drain them, even though this entails considerable work, for several of them are so extensive that control by any other means is doubtful. Moreover, oiling is but a temporary expedient and a comparatively costly one.

A great deal depends on the amount and spacing of the rains. Two rains falling within a week are liable to cause water to stand in roadside ditches for a time sufficient to cause breeding. To care for such a contingency, a ditching machine, drawn by 6 mules, is used to clean out the roadside ditches and remove the grass and weeds. This allows the sun every chance to dry up the water and also furnishes better drainage facilities than the grass-filled gutter; it also allows of easier and cheaper oiling.

**Temporary Use of Oil.**—Pending the work of cleaning out the streams and draining the pools and sloughs, some method of control is necessary; in many cases it is necessary even after the streams have been ditched and cleaned. Oil is utilized for this work. Ordinary crude oil is used for the most part, mixed in the proportion of two parts of crude oil to one part of coal oil to make the mixture thinner and easier to handle. This may be applied in several ways. The method most in use around Camp Bowie is by the hand spray. A knapsack shaped can, holding about 5 gal. of oil, is strapped to the back of the oiler. By means of a small pump and a spray nozzle the oil is applied in a thin film to the surface of the water. Oil may also, in the case of running streams, be applied by a drip can regulated to deliver 20 to 30 drops of oil per minute. The oil forms a film on the surface of the water and by shutting off the air supply of the baby mosquitoes, kills them in a short time.

## A Couple of Arguments for Metering

Some comment has been caused by the fact that on one day last summer the pumpage for the water works of Philadelphia reached 359,000,000 gal. or more than 200 gal. per capita. This broke all previous records for the city, and is something of an accomplishment. Chicago, however, can give the Quaker City points on water consumption and waste. According to the last annual report of the Department of Public Works, the quantity of water pumped in Chicago in 1917 totaled 234,132,030,000 gal. or an average of 245 gal. per capita per day. And this quantity was slightly less than that pumped in 1916, the summer season of which was unusually hot and dry.

## 40,000 Gal. Reinforced Concrete Tower and Tank Built for $3,100

A 40,000-gal reinforced concrete water tower and tank was built for the village of New Trier, Minn., in 1917. It is a plain, circular structure, the tower and the tank portions being of the same diameter, 16 ft. inside, and the same wall thickness, 6 in. The design and construction features of the structure are described by Mr. H. G. Overholt, of the Circular Concrete Co., Minneapolis, the contractors, in Concrete, to which we are indebted for the matter following:

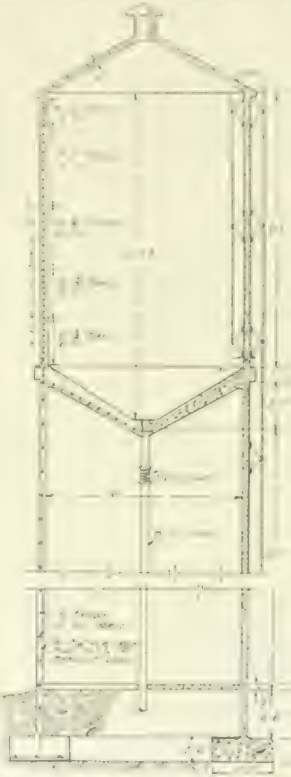

Fig. 1—Design Features of 40,000 Gal. Water Tank on a 50 ft. Concrete Tower

**Foundation.**—The foundation is an annular ring of concrete, 5 ft. wide and 2 ft. 6 in. thick, reinforced with $\frac{3}{4}$-in. rods 15 in. o. c. both ways. The bottom of foundation was placed 7 ft. below the ground surface on a hard and firm clay. From the top of this foundation the walls extend up to the bottom of the tank floor, 50 ft. above ground as a plain cylinder. At the ground line openings for a door and two small windows were provided.

The reinforcement in this tower portion consisted of $\frac{1}{2}$-in. round hooping 2 ft. o. c. for the entire height. The verticals are 16 lines of $\frac{3}{8}$-in. sq. twisted rods, with 16 extra $\frac{1}{2}$-in. square twisted rods 12 ft. long at the bottom.

**Tank Floor.**—The floor of the tank is an inverted cone, with a rise of 5 ft. The normal thickness of concrete at the center is 9 in., at the inside wall line 15 in. A reveal 14 in. deep and extending 6 in. outside the wall line, was poured monolithically with the floor with the double purpose of breaking up the outer surface and providing additional bond length for the radial reinforcing rods, which were all ½ in. square, twisted, spaced 10 in. o. c. as measured at the inside wall surface. One-half of these radial rods were bent up to the top of the floor slab about 3 ft. inside the wall, to act as shear reinforcement. The other half of the radials follow the bottom of the floor to near the wall line, whence they are bent on an easy curve into a vertical position. Hooping in the tank floor is ½-in. square twisted rods 10 in. o. c.

**Walls.**—The reinforcement in the tank walls was designed on an arbitrary basis as to allowable unit stresses in the steel at various depths. A unit stress of 9,000 lb. per square inch was adopted for a depth of 20 ft., 10,000 at 16 ft., 11,000 at 12 ft., 12,000 at 48 ft., and 16,000 at 2 ft. The spacing of hoops was considered such as to make use of vertical reinforcing unnecessary, except as spacer bars. Sixteen lines of ½ in. squares were used in this way.

**The Roof.**—In the cone-shaped roof, which has a rise of about 5 ft., the reinforcement could be omitted with entire safety, and the thickness of concrete need not be over 3 in. in this size tank. But as will be seen from Fig. 1, a small amount of ⅜-in. reinforcing was provided.

**Concrete.**—The concrete mixtures were as follows: Foundation, roof, floor of tower, and tower wall, 1 cement, 2½ sand and 5 screened gravel. Tank walls and tank floor, 1:1½:2½ mix. The sand was reasonably coarse, the gravel clean and graded from ½ in. to 1¼ in. Special care was exercised in proportioning, mixing and placing the tank floor and the lower part of the tank walls.

The inside of the tank wall and floor was given first a heavy coat, about ½ in. thick, of 1:2 mortar, followed by a ¼-in. coat of 1:2 plaster, mixed quite wet. The wall and floor coats overlapped at the bottom of the wall, making four thicknesses at this very vital point, resulting in a nicely rounded fillet. On the day following, two brush coats of neat cement were applied.

Two very slight drips through the floor were easily stopped by additional plaster. A few moist spots developed on the outside of the walls after the tank was filled to full depth, but these soon disappeared.

Considering the thin wall and the depth of the water, this showing was unexpectedly creditable. With equally good aggregates, full theoretical amount of cement, and plastering and finish coats as here used, it is believed that water-tightness is within the powers of any careful, conscientious and intelligent crew.

**Method of Construction.**—A special steel form outfit made by the Polk-Genung-Polk Co., Fort Branch, Md., was used on the tower and tank wall. Material was hoisted on a swinging crane, mounted on the steel forms in a 2 cu. ft. V-shaped dump bucket. A 2-lever Louden barn hoist of very light construction, operated by a 3-Hp. gas engine, was used with very satisfactory results.

Material for the tank floor, roof and plaster was also hoisted on the crane, the centermast of the form outfit passing through the 8-in. riser pipe, while a small hole was left through the floor for the hoist cable.

Forms for the floor and roof were of trapezoidal 1-in. boards on 16 2-in. x 6-in. rafters. The same material was used for floor and roof forms, with very slight alterations, after which the boards were used in the boxing for the riser pipe.

Pouring the floor proved to be the most exacting part of the work. It is worth while to take every possible precaution to ensure a steady and continuous run for the floor. Pouring a portion of the wall as a monolith with the floor is a desideratum often striven for but seldom attained. It is well to have ready strips of sheet metal about 4 in. wide, crimped together at the joints, to be placed half in and half out of the concrete on the center line of the wall at the joint between floor and wall, and for a couple of the lower joints in the wall concrete. The top of each run was thoroughly flushed with water, lightly sprinkled with dry cement and thinly covered with a creamy neat cement before depositing the regular mixture. The slightest relaxation in the care with which such details are attended to may result in serious trouble.

**Riser Pipe and Boxing.**—The riser pipe is 8 in. cast iron water pipe, with flanged connections. It was erected in 20-ft. lengths with block and tackle, without the use of staging. The short length, at the top (Fig. 1), was concreted into the floor and had no structural connection with the pipe from below, the weight of which rested on a concrete saddle placed underneath the tee in the supply main at the foot of the riser.

A Dayton expansion joint was slipped over the two plain ends, making an easily applied and inexpensive connection. This type of joint is not recommended by the makers for heads in excess of 30 ft.

After a coating of tar paint, the pipe was boxed in a tripe lagging of 1-in. boards separated by lath and two layers of tar paper.

In extremely cold weather it is intended to pass the heat from a small stove up into this boxing. With the air tight concrete tower enclosing stove and riser, a marked saving in fuel and attention required is anticipated. Indeed it seems as if the riser pipe boxing could almost as well be dispensed with entirely in a tower of this sort.

In small villages this tower space may be utilized in various ways, as for drying out fire hose by hanging it up endwise, storage of property, or for a jail cell. An application which will prove very economical is to house the jumping machinery in the base of the tower, thus saving the full cost of the pump house superstructure.

**Cost.**—This structure was built in an inland town 2½ miles from a railroad. Sand was the only material not shipped in and hauled. The contract price was $3,100.

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**New England W. W. Assoc. Meeting Sept. 11 and 12.**—The customary fall convention of the New England Water Works Association has been abandoned on account of the war, and instead a business meeting is being held at Boston, Mass., Sept. 11 and 12. This will be a win-the-war meeting. Its papers and discussions will be devoted especially to problems of conservation, fuel economy and problems resulting from the high cost of materials and labor. The headquarters will be at the association rooms, 715 Tremont Temple, and the meeting will be in Chipman Hall on the floor below.

# The Automatic Superdam of the Gun Powder River Water Supply of Baltimore

In order to avoid injury to the waterpower of a mill the Lock Raven Dam of the water supply system of Baltimore, Md., was topped off with an automatic superdam or tilting dam. The masonry dam was completed on Nov. 1, 1913, to an elevation of 183 ft. A.M.T. The tilting dam was installed last year and brings this elevation to 192 ft. A.M.T. An interesting description of the design and construction features of this tilting dam are given by Mr. V. Bernard Siems, Pitometer Engineer, Baltimore City Water Department, in a paper presented at the St. Louis Convention of the American Water Works Association. An abstract of the paper follows:

The present spillway has a length of 321 ft. at elevation 188 ft., and as this crest has keyways for future raising of dam the center one was utilized for the location of the anchor block, which in turn acts as pivot for the tilting dam.

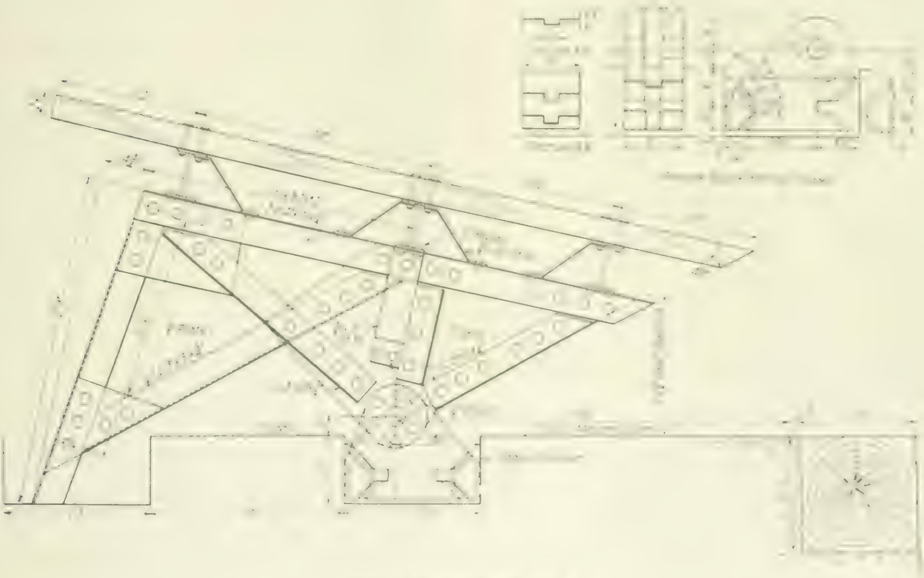
To provide a tilting or otherwise movable superdam in this spillway, in one unit, was impracticable for structural reasons. More so, however, was this undesirable from the standpoint of waste of water. The tilting dam was arranged so that a portion would tilt when the water reached an elevation of 193.5 ft. A.M.T., a depth of 1.5 ft. of water on crest of movable dam. If the flood continued to rise, other portions tilt in turn at different elevations.

The width of spillway was divided into 27 units or separate dams, numbered from 1 to 6. Each numbered section is arranged to tilt at a different height of water over crest. The summary below shows the number of each kind of unit, and head under which they are designed to tilt:

| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | | |
| [illegible] | [illegible] | [illegible] | | |
| [illegible] | [illegible] | [illegible] | | |

**Details of Tilting Dam.**—All sections are 4 ft. high (top of spillway to crest of movable dam) except Section 1, which is 3 ft. 9 in. in height. The reason for making Section 1 (composed of four 12-ft. and one 9-ft. sections, a total length of spillway of 57 ft., all at elevation 191.75 A.M.T.) lower than the others was because of the desire to confine the normal water flow up to 192 ft. A.M.T., also logs, etc., to center of stream. Section 2 was designed to tilt under the minimum head of 1.5 ft. because the intake channel, having an approximate elevation of 170 ft. A.M.T. at the gate house, starts opposite this location (Sec. 2), and therefore by an increased velocity, due to the water being confined to this location, the deposit of silt at end of tilting dam will be kept away from this channel and also the channel to 48-in. sluice gate, whereas if No. 1 was made to tilt at the minimum head the deposit of silt would fill the entrance to channel.

The original topography of the river necessitated the excavation of a channel from the original stream bed in order to bring the water to gate house at the lowest elevation. The form of dam chosen was that of an obtuse triangle, pivoted at the obtuse angle, and forming a typical hollow or framed dam. As the water rises on a section its center of pressure on the inclined dam surface also rises, and eventually the pressure normal to the back will strike through the hinge. At this time neglecting the weight of dam, the structure will be in neutral equilibrium. As the pressure rises still further, the normal strikes above the hinge, and tilting takes



Details of Tilting Dam No. 6

place, the dam falling to take its second or open position.

**Test of Dams Under High Water Conditions.**—The dams have been subjected to high water conditions, and sections Nos. 1, 2 and part of 3 have tilted. Upon subsidence of the water these dams returned to their normal positions. In many cases the elevation varied from 0.3 ft. to 0.6 ft. lower than that for which they were designed. There can be numerous reasons for this; i. e., as the water subsides and reaches near elevation 188 ft. A.M.T. foreign matter lodges at the toe, and when dam drops back it sets on this obstruction, thereby throwing it forward. This is also the case when warping of timber decking at toe and at ends of section takes place. In both cases the tendency is to decrease the head necessary for tilting. The friction and corrosion at pin also offer resistance to tilting.

It is interesting to note that as dams tilt, I-beams and timber decking offer some obstruction to stream. This is especially true as the water subsides. The free waterway from bottom of lower I-beam to concrete top of dam (elev. 188 ft. A.M.T.) is 1 ft. 2 in., giving an opening of 1.2 ft. x 321 ft. or 385 sq. ft., obstructed only by upright framing of dam. The tilting dam usually drops back when water reaches an elevation of 188.75 ft. A.M.T. or slightly lower. This proves conclusively that the dams are entirely automatic in their action.

**Unique Features of Bearing Castings.** — The casting used as bearings for the dams has several unique features. The center keyway on top dam was utilized for the anchoring of castings. It was necessary to cut groove to 14 in. width at anchor blocks, as the 12-in. original groove was irregular in alignment and did not give room for lining up casting. The castings for anchor blocks are different for each section of frame. Distance from back face of keyway to pivot for Frame 1 is 4 5/16 in., and for No. 6 8½ in.

The groove for a width of 6 in. having been lined up on the upstream side, the castings were all set with reference to this edge. The castings are three in number—a center block with hole for pin, and two side setting pieces and wedges. The center block was first set to position, then the side pieces slid in and tightened against the sides of groove by wedges. After aligning and wedging in position space under castings was filled with 1:2 grout, and spaces between side pieces and block were filled with lead. This gives absolutely rigid construction, limited only by the strength of the concrete in grooves of present masonry dam.

The total cost of the construction of these tilting dams amounted to approximately $3,700. This work was originally let for contract, two bids being filed, one for $5,275 and the other $9,280. Since the estimate made by the Water Department amounted to $3,200, the bids were rejected, and the work done by the department's forces at the above mentioned figure.

By the construction of this tilting dam and the consequent raising of the water surface from elev. 188 ft. to 192 ft. A.M.T., a considerable saving in electric power consumption at the low lift pumping station was realized; e. g., with an assumed pumpage of 90,000,000 gal. per day the saving was approximately 1,500 kw. per day, or 547,520 kw. per year, which at a cost of 0.8 of a cent per killowatt gives a saving of $4,380 per year.

# Electrically Operating Sewage Pumping Stations of Waterloo, Ia.

As cities expand and more territory is added, it frequently happens that these additions are at a lower elevation than the existing sewers, thus necessitating the lifting of the sewage from the new annexations. At Waterloo, Ia., this problem is being handled by three small pumping stations. An interesting description of these stations was given by Mr. G. H. Kilpatrick, Assistant City Engineer, in a paper presented at the last annual meeting of the Iowa Engineering Society, from which the matter in this article is taken.

**Cedar River Park Station.**—Cedar River Park, containing approximately 30 acres, was annexed to the city in 1913 and in the early summer of 1914 plans were made to relieve the sanitary conditions. It was found that a greater part of the new annexation could be served by extending the present sewer system and that a part would have to be taken care of through a lift station. The part of the addition from which the sewage had to be lifted will ultimately consist of 102 dwellings.

It was estimated on the basis of each family of 5 persons using 80 gal. per capita per 24 hours that 40,800 gal. would have to be pumped daily. It was decided to install an American Well Works submerged centrifugal pump, motor driven, vertical shaft, type CMD, with a 6-in. suction and a 4-in. discharge. The pump is driven by a 7½-HP., 60-cycle, single-phase, 220-volt, A. C. Wagner motor equipped with an automatic controlling device. The lift is 8.7 ft.

The reservoir is rectangular, 8x12x12 ft. The walls are of 1:3:6 concrete 8 in. thick, with ½-in. bars spaced 18 in. center to center. The floor is 3 ft. below the inlet pipe and is of the same class of concrete as the walls. It has a slope of 3 in. toward the pump. The storage below the inlet is 2,160 gal. The roof of the reservoir is 8 in. in thickness and of 1:2:4 concrete, reinforced with ⅝-in. round corrugated bars, spaced 6 in. A ¾-in. iron rung ladder, spaced 16 in. center to center, is set in the concrete wall of the reservoir. Two vertical screens made of No. 4 galvanized iron wire on substantial iron frames, held in place by grooves in concrete pilasters extending 4 ft. above the floor of the reservoir, divided the pump from the main part of the storage.

The pump house is 9x9 ft. inside and constructed of first class hard brick masonry. It has a frame roof and a ventilator, and is covered with asphalt shingles.

The cost of this station was as follows:

| | |
|---|---|
| Concrete reservoir | $ 700 |
| Brick pump house | 265 |
| Pumping outfit, complete | 505 |
| Total cost | $1,470 |

Cedar River Park still continues to be more of a summer home addition than one of permanence, although each year a number of new modern homes are built. A careful census of this sewer district taken in the early winter of 1917 shows 86 persons. The record of operation of this station shows that the residents served have been "Hooverizing" on the amount of water used for sanitary purposes. The station has pumped 57 times from Jan. 20 to Feb. 20, 1918. The amount of sewage was 65,136 gal., giving an average daily amount of 2,005 gal. of approximately 23.3 gal. per person.

The first winter after this station was put in operation considerable trouble was experienced from freezing because of the small inflow of sewage. A hot water radiator was suspended from the roof of the reservoir and connected with a gas heater, which relieved this trouble. Since that time more connections have been made to the system entering this station, because of the construction of a number of modern homes, and the increased quantity of sewage entering the reservoir retains enough heat to keep it from freezing.

The odors coming from the reservoir through the ventilator have caused some discomfort to the residents living near the station, especially in warm weather. It would be advisable to provide some kind of a water connection into a station of this kind to which a hose could be attached. By using a brush and the water pressure combined on the sides of the walls of the reservoir and on the pump, the cause of these odors might be removed.

**Fullerton Ave. Station.**—The territory served by this station consists of but 31 residential lots, owing to the fact that the tract of ground is now enclosed on three sides by public park property. At the time this station was planned, the property bounding this tract on the west was held in trust and it was uncertain as to what might be done in the way of subdividing. It was estimated that there would be 3½ times as many lots platted and added to this tract as were in the district that needed immediate sewage. Estimating 5 persons to the lot using 50 gal. per person, times 3½ for the proposed additional lots, meant pumping 27,125 gal. per day.

This station is of a semi-submerged type, the roof of the reservoir being 4 ft. below the natural ground level. The reservoir is circular in design, 7 ft. in diameter, and built of old pavers laid in rich cement mortar and plastered on the inside. The floor of the reservoir is 3½ ft. below the inlet and the storage capacity is 1,010 gal. The pump house is circular, 6 ft. in diameter, and is built of first class hard red brick masonry and has a galvanized roof. The equipment consists of a 3½-HP., 60-cycle, 104-volt, AC Century motor with an automatic controlling device, and an American Well Works submerged centrifugal pump No. 3, vertical shaft, type CMD, with 3-in. suction and 3-in. discharge. The lift is 11.62 ft. The cost of this station complete and ready for operation was $922.

Considerable trouble was experienced in excavating for the reservoir. The soil to a depth of about 8 ft. was sand loam, underlaid with a bed of granite boulders, ranging from 4 to 12 in. in diameter, very closely cemented with clay. Underlying these boulders was a lime rock of stalagmatic formation to a depth of 7 ft. It was necessary to keep a pump working while this rock formation was being removed. At the center in the bottom of this reservoir excavation there was a seam in the rock through which the water boiled. In laying the 6-in. concrete floor in the reservoir some difficulty was experienced on account of this water pressure. Three thicknesses of heavy canvas were laid on the rock in an endeavor to overcome this pressure. This was not a success, and at the place where the water pressure was greatest a piece of concrete, 2x2 ft., was removed. The seam in the rock was then driven full of untreated yarn, and several additional layers of canvas placed over the seam, and the opening again filled with concrete. This failed to hold the pressure, and another opening was made. A 2-in. pipe was placed at the point where the water boiled the hardest, and the opening in the concrete again filled. This plan worked successfully. Later the pipe was cut off and capped.

The pumping record of this station from Jan. 20 to Feb. 20, 1918, shows 15,302 gal. were pumped, or a daily average of 510 gal. There are at present 20 people served by this station, which gives a daily average of 25.5 gal. per capita.

**Falls Ave. Station.**—This station was planned to take care of a large tract of land, which is separated from the city of Waterloo by Black Hawk Creek, and for the most part is at so low an elevation that a lift of 18 ft. is necessary. The system is planned to be a separate system and the sewage from a future population of 10,250 is to be handled through this station. All surface water is to be taken care of by a storm sewer.

In estimating the quantity of sewage this station must handle the same number of persons per lot and the same number of gallons per person were used as for the Fullerton Ave. Station.

The reservoir is rectangular, 8x12x20 ft. The walls are 8 in. in thickness of 1:3:6 concrete and have a batter of 9 in. in 20 ft. These walls are reinforced with four ¾-in. horizontal bars, three ⅝-in. square horizontal bars, and three ½-in. square horizontal bars, all spaced 2 ft., with ½-in. vertical bars spaced 3 ft. All bars were placed 2 in. from the inner face of the walls. The roof of the reservoir is reinforced with ½-in. square bars placed 1½ in. above the bottom of this roof slab. This roof has a projection of 6 in. on all sides and is 10x14½ ft. x 8 in.

The pump house is 8x12 ft. inside and built of first-class red brick masonry, laid with lime and cement mortar. The floor has 2 manhole openings and 2 openings for pump installations. A window was placed in each of 3 sides and a 3½x7-ft. door on the street side.

The present pumping unit consists of a 5-HP., 60-cycle, 3-phase, 900-RPM. Lincoln motor, and a 400-GPM American Well Works submerged centrifugal pump, vertical shaft, type CMD, having a 4-in. suction and a 4-in. discharge, and is controlled by an automatic starting and stopping device. A vertical screen, having a 2-in. mesh and made of No. 6 galvanized iron wire on a substantial iron frame, and a 6-in. partition wall, separate the pump wells from the main part of the reservoir. The screens are held in place by grooves in the concrete partition and pilasters at the sides of the walls of the reservoir. The pump wells are 3.66x4x6 ft.

A 12-in. gate valve is set in the wall of the reservoir at such an elevation that it will be possible at all times of the year to thoroughly flush the reservoir with water from Black Hawk Creek. A tight plank floor was placed 6 ft. below the roof of the reservoir. The total cost of this station was $2,775.

At the present time there is but one residence connected to the system leading into this station, but all of the factory waste and the sewage of the William Galloway Co. factories and offices, and several other closely connected factories, is handled through the station. The station is handling 1,260,000 gal. per month, or a daily average of 42,000 gal. from 884 employes, or 47.6 gal. per person.

The construction of this station caused considerable aggravation to the contractors and all concerned for two reasons: first, the bottom of the reservoir is 5 ft. below low water in Black Hawk Creek, which necessitated the use of double sheeting and two centrifugal pumps; and second, the reservoir and pump house were built in freezing weather, which required the heating of all materials and the use of salamanders.

# Method of Recovering a "Lost" Pump from Deep Well

A "fishing tool," consisting of two rings, was employed by the Water Department of Mason City, Ia., in recovering a turbine pump which had dropped down a deep well. The method was described by Mr. W. A. Judd, Superintendent of Water Works, in the June Journal of the American Water Works Association. The well starts with a 19-in. hole which continues for 225 ft. At that point the diameter is reduced to 16 in. and at 540 ft. it is again reduced to 12 in. The well is 1,200 ft. deep. In this well is installed a 5-stage 17-in. American deep-well motor-driven turbine. The turbine proper is about 90 ft. below the well curb and below the turbine are two lengths of 9-in. suction pipe. Water normally stands in the well about 85 ft. below the curb and pumps down about 7 ft. when yielding 1,200 gal. per minute.

The pump is overhauled each year. On New Year's day, 1917, the pump had been lowered together with four lengths of discharge pipe, shaft casing and shafting. The fifth length of shafting had been screwed up tight and the fifth shaft casing was being set up solid when, without any warning, casing and shaft disappeared through the discharge pipe and with the pump and two lengths of discharge pipe went down to find a resting place on the ledge 225 ft. below the surface. The two remaining lengths of discharge pipe were pulled out and it was found that in making up the shaft casing joint, the discharge pipe had worked loose from the flange.

An attempt was made to couple on to the shafting, which projects about a foot above the bearings. One of the shaft couplings was taken to a machine shop and the threads recut to make a loose fit. One end was tapered out on the inside and the other end was cut down to take a 2-in. pipe coupling. On the bottom was soldered a heavy funnel to center the coupling over the shaft. Two-inch pipe was then cut into about 10-ft. lengths for ease in handling and threaded. Because the shafting has a left-hand thread, it was necessary to drill each pipe coupling after the joint was made up and pin the pipe and coupling together. This was a tedious process, but finally the funnel was heard to strike the shaft. It was then raised and lowered a few times to be sure of centering and the men began to twist the pipe to the left. After several attempts, it seemed to take hold and hoisting was attempted with an 8-ton chain hoist which hangs from a trolley running on a 15-in. I-beam near the roof of the pump house. From the hard pull, it was known that the coupling caught hold of the shaft, but at about the third pull on the chain, the coupling became loose and for a day the men fished continuously without getting another nibble. The string of pipe was then pulled out and it was found that the funnel had bent over, allowing the shaft to center in the funnel to one side of the coupling. A heavier funnel was built, reinforced with steel ribs and bands, but even with this there was no luck, the shaft turning every time the threads engaged.

The method employed with the 2-ring fishing tool was as follows: The small end of the funnel was cut off so the hole through it was about 5 in. in diameter. A fork was made to which the funnel was riveted. Above the fork was welded a piece of 2-in. shafting 3 ft. long in such a way that when the shaft and funnel were vertical, the face of the steel was about 2½ in. from a vertical line drawn through the center of the funnel. On the back of this bar, two ears were welded and punched for a 1-in. bolt. Two open rings were made, 5 in. in diameter, of ¾-in. square steel with the ends bent back, flattened out and punched for a 1-in. bolt. The top of the bar had a piece of 2-in. pipe welded to it, the rings were bolted to their places and wired together so they would move together on the bolts and a light wire was fastened to the top ring to hold them in a horizontal position.

The whole apparatus was then lowered into the well with the same 2-in. pipe, the wire being paid out as the tool descended. The funnel centered the tool over the shaft casing all right, but when the rings were dropped by slacking on the wire, they did not bite into the casing enough to stand a pull so the tool was again pulled out, a tool-steel face put on the the rings and then notched. A piece of flat tool steel was welded to the face of the vertical bar, and in it were cut some teeth, making it look like a wood rasp. The tool was again lowered and caught hold of the shaft casing with a grip that scarcely anything could disengage. At the first pull it was evident that the pump was wedged tightly into the well, for, instead of the pump rising, the I-beam above was bending. Men were sent for props to put under the beam, but while they were gone the tension on the hoist suddenly slackened, showing that the pump was loose in the well and pulling was tarted. After pulling continuously for several hours the pump was landed on blocking on the well curb.

# Tentative Standards for Sewage Treatment

Standards for sewage treatment for industrial housing developments are summarized by the Engineering Division of the Bureau of Industrial Housing and Transportation of the U. S. Department of Labor in its tentative instructions to designers of sanitary facilities for the developments. The following tabulation from the instructions, show the suggested practice ordinarily applicable. The conclusions given are stated to be tentative only, and local considerations may alter the figures in any given case.

TABLE SHOWING TENATIVE STANDARDS FOR SEWAGE TREATMENT.

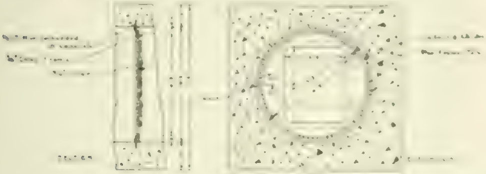
| | For fresh sewage 4 to 7 hours old, still containing dissolved oxygen. | | For old or decomposed sewage 6 to 25 hours old, devoid of dissolved oxygen. | |
|---|---|---|---|---|
| | Separate sewers. | Combined sewers. | Separate sewers. | Combined sewers. |
| Grit chambers | Velocity of flow, 8 in. to 2 in. per second. | Velocity of flow, 8 in. to 2 in. per second. | Velocity of flow, 8 in. to 2 in. per second. | Velocity of flow, 8 in. to 2 in. per second. |
| | Capacity. | Capacity. | Capacity. | Capacity. |
| Separation and sedimentation compartments. | 2 cu. ft. per capita. | 3 cu. ft. per capita. | 2.22 cu. ft. per capita. | 3.33 cu. ft. per capita. |
| Sludge digestion compartments | About 2 cu. ft. per capita (small cities 5,000 and under). | About 2 cu. ft. per capita (small cities 5,000 and under). | About 2 cu. ft. per capita (small cities 5,000 and under). | About 2 cu. ft. per capita (small cities 5,000 and under). |
| Sludge beds | 0.1 sq. ft. per capita. | 0.15 sq. ft. per capita. | 0.3 sq. ft. per capita. | 0.4 sq. ft. per capita. |
| Trickling filters for about 6 ft. depth | 30.000 pop. per acre. | 20,000 pop. per acre. | 20,000 pop. per acre. | 12,500 pop. per acre. |
| Contract beds for about 4 ft. depth | 3,000 pop. per acre. | 2,500 pop. per acre. | 2,500 pop. per acre. | 2,000 pop. per acre. |
| Sand filters (natural conditions only artificially improved). Depth about 3 ft. | 1,800 pop. per acre. | 1,500 pop. per acre. | 1,200 pop. per acre. | 1,000 pop. per acre. |
| Sand filter (high grade selected sands and gravels, fully built up along water works standard lines). Depth about 3½ ft. | 2,500 pop. per acre. | 2,000 pop. per acre. | 2,000 pop. per acre. | 1,600 pop. per acre. |

# Labor Cost of Constructing 4 ft. Brick Sewer in Tunnel

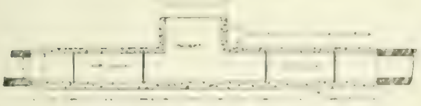
During 1917 the city of Toronto, Ont., constructed 1,146 ft. of storm sewer in Pape Ave., extending from Danforth Ave. to the northern city limits. The sewer is circular in shape, 4 ft. inside dimensions, and is made of two rings of brick, the total thickness of the walls being 9 in. The construction features of this sewer were described by Mr. R. T. Grant Jack, who was resident engineer for the city, in a recent issue of the Canadian Engineer, from which the matter in this article is abstracted.

The usual borings were taken along the line of sewer, and very hard blue clay was found at the elevation of the sewer, up to a point about 500 ft. north of Danforth Ave. North of this point, wet sand was found; therefore, two designs were adopted, one with circular base for good ground and the other with a square base to be used where soft ground was encountered.

**Construction Methods.**—Work was commenced at station 3 + 00, where shaft No. 1 was sunk and tunnels carried north and south. The excavated material was conveyed to the shaft in cars, hoisted by a derrick, dumped into wagons and carted to a city dump for use as "fill." The construction material was carried into the heading on the same cars. The clay was so hard that it necessitated the use of dynamite. Very little timbering was required, but if the clay was exposed to air for any length of time, it would shell off in large pieces, so two or three crown planks were used for protection of the workmen.



DETAIL OF STEEL [illegible]



[illegible]

Details of Design of Lock

After the south heading had been driven to the end, a drop connection was made in tunnel with the existing storm sewer on Danforth Ave.

In the north heading it was found to be too expensive to continue operation after station 4 + 95 was reached, as the ground changed very rapidly from the hard clay to wet sand. The remainder of the work, 950 lin. ft., was carried on from station 8 + 85 where shaft No. 2, 12 ft. x 10 ft., was sunk; but on reaching the elevation of the arch of sewer, it was found that the sand was very wet and that it would be almost impossible to do any tunneling without the aid of compressed air. It was decided to install an air compressor, and the shaft was enlarged to 65 ft. x 10 ft., to allow for the construction of locks. In the last 7 ft. of excavation, tongued and grooved sheeting was used, driven down 1 ft. below subgrade. This facilitated excavation and reduced the amount of water.

In constructing the locks, a concrete slab was placed and leveled down; when this concrete was well set the invert forms were placed and more concrete poured. When this had set sufficiently to allow the removal of forms, they were reversed and used for the arch. Prior to placing concrete in the arch, all the pipes for the air lines and the iron frames for the lock doors were put in place, so that a bond would be obtained between the iron and concrete, thereby eliminating any loss of air at such points.

After the locks were completed, the trench was back-filled, care being taken that it was tamped and watered well, so that the least possible amount of air would be lost.

Two compressors were put in place, so that if one was not able to supply sufficient air, the second could be used. It was found necessary to use the two nearly all the time owing to loss of air through private drains which connected the houses on the east side of the street to the local sewer.

With the aid of the compressed air, very good headway was made and the 888 ft. of sewer were completed in less than 7 weeks. Three of the five manholes were partly constructed from below and afterwards excavated from the surface and finished.

The method of construction was practically the same as in the first section. As material excavated was sand, sheeting of the crown was required throughout. The square base design was used so that when the compressed air was removed there would be a good bearing surface for the sewer, with less danger of settlement of the sewer after the water returned.

The entire contract was executed by the Fussell and McReynolds Co., Limited, Toronto, and was completed in $4\frac{1}{2}$ months. The work was under the direction of the Works Department of the city of Toronto, of which R. C. Harris is Works Commissioner, and George Powell, Principal Deputy City Engineer. W. R. Worthington is engineer of sewers; W. G. Cameron, engineer of maintenance and construction; and W. S. Harvey, engineer in charge of design.

**Unit Costs.**—In the following unit costs, for convenience a "key" is used in reference to the distribution of labor, as follows:

[illegible]

[illegible]

| | | |
|---|---|---|
| [illegible] | [illegible] | [illegible] |
| Excavation in tunnel | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | cu. yd. |
| [illegible] | [illegible] | cu. yd. |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | cu. yd. |
| [illegible] | [illegible] | ft. |

[illegible] SHAFT NO. [illegible]

| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

| | | | | |
|---|---|---|---|---|
| Engineer | K | 231 | 1.12 | .47 |
| Labor | K | 1,432 | 7.00 | 2.90 |
| Engineer | Q | 54 | .... | .11 |
| Labor | Q | 85 | .... | .18 |
| Teams | Q | 85 | .... | .18 |

UNIT COSTS IN HOURS, SHAFT NO. 2.

| Item. | Distribution. | Time in hours. | Hours per cu. yd. | Hours per lin. ft. |
|---|---|---|---|---|
| Foreman | A | 200 | .43 | .... |
| Teams | A | 70 | .15 | .... |
| Labor | A | 1,760 | 3.80 | .... |
| Engineer | A | 105 | .23 | .... |
| Foreman | E | 40 | .65 | .... |
| Engineer | E | 15 | .25 | .... |
| Labor | E | 470 | 7.70 | .... |
| Foreman | N | 580 | .64 | .65 |
| Engineer | N | 512 | .57 | .58 |
| Miners | N | 1,620 | 1.80 | 1.84 |
| Labor | N | 2,457 | 2.73 | 2.75 |
| Teams | D | 488 | .54 | .55 |
| Bricklayers | K | 816 | 1.56 | .86 |
| Labor | K | 3,860 | 7.40 | 4.06 |
| Engineer | K | 488 | .93 | .51 |
| Operators | S | 522 | .58 | .60 |
| Operators | T | 546 | 1.04 | .63 |
| Oilers | U | 212 | .24 | .24 |
| Oilers | V | 200 | .40 | .22 |
| Engineers | J | 201 | .... | .21 |
| Labor | J | 90 | .... | .10 |
| Foreman | Z | 40 | .... | .04 |
| Labor | Z | 500 | .... | .50 |
| Labor | P | 390 | .... | .42 |
| Teams | P | 410 | .... | .44 |
| Labor | C | 560 | 1.30 | .... |
| Teams | C | 36 | .09 | .... |
| Engineers | Q | 144n | .... | .15 |
| Labor | Q | 435 | .... | .46 |
| Teams | Q | 81 | .... | .09 |
| Engineers | CP | 410 | .... | .46 |
| Labor | CP | 667 | .... | .76 |
| Teams | CP | 114 | .... | .13 |
| Engineers | TD | 70 | .... | .08 |
| Labor | TD | 35 | .... | .04 |

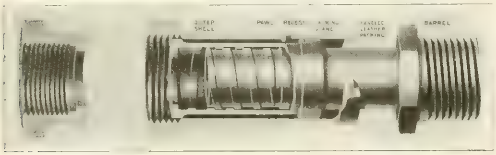
QUANTITIES, SHAFT NO. 2.

| | |
|---|---|
| 4-ft. two-ring brick sewer with square base | 951 lin. ft. |
| Air locks | 63 lin. ft. |
| Excavation in tunnel | 900 cu. yd. |
| Excavation in shaft | 462 cu. yd. |
| Surplus excavation | 900 cu. yd. |
| Back-filling shafts and manholes | 427 cu. yd. |
| Brickwork | 523 cu. yd. |
| Concrete in locks | 61 cu. yd. |
| Bricks in tunnel | 156,750 |
| Bricks in square base | 28,500 |
| Bricks in four manholes | 14,200 |
| Brick packers | 11,780 |
| Cement (brickwork) | 2,080 bags |
| Cement (concrete) | 305 bags |
| Sand | 240 cu. yd. |
| Stone | 60 cu. yd. |
| Timber (entire contract) | 10,930 ft. B.M. |
| General supervision— | |
| Foreman | 132 days—.92 hr. per lin. ft. |
| Material foreman | 66 days—.46 hr. per lin. ft. |
| Timekeeper | 66 days—.46 hr. per lin. ft. |

Sizes of shafts—
Shaft No. 1—7 ft. 3 in. x 9 ft. 10 in. x 22 ft. deep.
Shaft No. 2—10 ft. x 65 ft. x 22 ft. deep.

## New Expansion Coupling

A new expansion coupling designed by Mr. E. H. Ford, of the Ford Meter Box Co., is shown in the accompanying illustration. This coupling, while devised primarily for the purpose of connecting water meters into straight line pipes, may be used in any place where flexibility is required in water, gas or steam piping. It is made now in three sizes, for 5/8 in., 3/4 in. and 1 in. meters, and may be used in connection with 1/2 in., 3/4 in. and 1 in. pipe. No special tools are required for its installation. The coupling is composed of only three parts and the three sizes mentioned provide expansion ranges of 5/8 in., 7/8 in. and 1 in. respectively. Sample couplings have been subjected to test pressure of 300 lb. without showing leak. The Ford Meter Box Co., Wabash, Ind., is now placing these couplings in production and expects soon to have them on the market.



Details of Expansion Coupling.

## Suggestions for Preventing Wasting of Water

The Committee on Water Supply of the New York State Conference of Mayors, in connection with a campaign to reduce the waste of water in various cities, has sent to water works officials in that state suggestions for bulletins to be printed in local papers. These suggestions include the following:

Have all leaky pipes and fixtures repaired immediately, and keep them in good order.

When closing your house for any period of time, see that the water is turned off to insure against a leak occurring during your absence.

Do not neglect leaking toilets and faucets. Large amounts of water are wasted through small leaks which you may think too insignificant to warrant attention.

A leak 1/32 in. in diameter wastes 8 gal. an hour or over 5,000 gal. a month.

A stream 1/4 in. in diameter will waste 514 gal. an hour or over 370,000 gal. a month.

If care is exercised, when installing piping, to keep the hot and cold water pipes at least 1 ft. apart, it will be unnecessary to "let the faucet run to get a cold drink."

Don't let water run to get it cold. Use ice, or draw some water off into a receptacle and put in a cool place.

Don't keep the faucet open while you are washing or bathing. Draw off as much as you need and then turn off the faucet.

Do not allow roof tanks to overflow. Eliminate this waste by providing tanks with ball cocks.

Don't leave faucets open on cold nights this winter to prevent freezing of water pipes. Start now to have your pipes properly protected.

To determine the presence of hidden leaks, consumers whose services are metered should occasionally close all outlets and observe the meter to see if it registers or not.

It costs just as much for coal, oil and equipment to pump and filter water that is wasted as it does to furnish water for useful purposes.

A gallon of water saved just now will help Uncle Sam to win the war.

But saving in water consumption may save not only in coal, but in iron and steel and other metals also. For several cities now are up against the alternative of reducing per capita consumption or increasing the supply; and the latter almost certainly means laying more pipe, and probably adding more pumping and boiler units if the supply must be pumped. Where the citizens are wasting water, they have no right to ask the Government to release steel, bronze, etc., and mechanics to fabricate them, from arms and ship works, in order that they may continue unhindered their wasteful practices.

**Device for Indicating Water Level in Reservoir.**—A simple device for showing the amount of water in a reservoir is employed by a western city. It consists of a wooden frame 12 ft. high, mounted on the reservoir. The frame is divided into spans, each representing 10,000 gal. A broad white board is moved up and down in the frame by a float that rises or falls as the water level changes. The arrangement is visible from the pumping station which is some distance away.

## Capacity Tests of a Water Tunnel

A capacity test of the Northwest land and lake water supply tunnel system of Chicago was conducted last year by the Department of Public Works, under the direction of Mr. F. A. Smith, Assistant Engineer. The test is described in the last annual report of the Department, from which the matter following is taken.

The tunnel system consists of 20,701 lin. ft. of 10-ft. diameter tunnel, extending from the Carter H. Harrison Crib in Lake Michigan 14,033 ft. from shore, to Green St. near Grand Ave. From this point one 8-ft. diameter tunnel extends to Central Park Ave. pumping station, a distance of 19,856 lin. ft., and another 8-ft. diameter tunnel extends from Green St. in a northwesterly direction to the Springfield Ave. pumping station, a distance of 22,183 lin. ft. Near the Oak St. shaft a branch tunnel 7 ft. in diameter runs southerly to the Chicago Ave. pumping station, gate shaft No. 1 in Seneca St. near Delaware Pl. being located on this connecting tunnel.

The tests were made in the following manner:

The mean velocity of flow was determined by observing the time it took for a sodium chloride (salt) solution to pass between various points. Thus, observers were placed at the Carter H. Harrison Crib, at Green St. shaft, and at the Central Park Ave. and Springfield Ave. pumping stations. At the crib a record was kept of the stage of the water during the test, and exact time noted when the salt solution was dropped into the shaft. The observers at the other points noted the exact time of the arrival of this solution by the use of an electrical indicator, and noted the elevations of the water at the various points and kept a record of the pumpage at the two pumping stations to be used as a check on the test and also to draw some conclusions regarding slippage.

The first test disclosed the fact that the water passing through the 10-ft. tunnel was 41.05 c.f.s. larger than the sum of the flows in the two 8-ft. tunnels, which represents the leakage through the 7-ft tunnel to the Chicago Ave. pumping station.

The data thus obtained have been computed by hydraulic formulae and show uniform results. Considering the variations in velocities the factor C varies only from a maximum of 126 to a minimum of 120 for the 10-ft. tunnel and the coefficient "n" varies from .0139 to 0.145. The values of the coefficient of roughness "n" for the Central Park Ave. tunnel gives an average of .0141; for Springfield Ave. tunnel, the value of "n" = .0134.

During the three tests the amount of pumpage was checked by pump indicators, by pitometers, and by the hydraulic tests.

This gives for the Central Park Ave. pumping station the following results:

[illegible]

[illegible]

At Springfield Ave. pumping station the observations as to pumpage were as follows:

[illegible]

[illegible]

Taken as a whole, the three tests have been successful, and show that the capacity of the Northwest land and lake tunnel is good for brick tunnels, and the coefficient of roughness is smaller than is usually found in tunnels of this size.

## Engineers to Study After War Conditions

President W. H. Finley of the American Association of Engineers, has appointed a committee of prominent engineers to study after-the-war conditions. The committee consists of Isham Randolph, chairman; Edmund T. Perkins, Consulting Engineer, Chicago; Gardner S. Williams, Consulting Engineer, Ann Arbor, Mich., and Samuel Moreell of Chicago, Secretary. The committee will be increased as it gets into the work and will join forces with other agencies in Chicago and throughout the country that are now studying the problem.

The questions for early consideration are largely those of human engineering. Behind these are certain broad principles upon which as a foundation plans for reconstruction and for the better employing of natural resources and man power are based.

The after-the-war problem may be defined as the rebuilding on normal peace lines of the activities, mental and physical, which prevailed before the war, with each improvement or advance in ideals, methods and machinery as may have been made possible by recent experience. It begins primarily with the returning soldier, in his rehabilitation if necessary, and his return to the industry which best suits his capacities and desires. It includes the placing of other war workers as conditions change and of any human effort where it may be most effective. It means better use of our natural resources in lands, minerals, waters and forests, to furnish larger and more nearly equal opportunities for each citizen, and the placing of industry, including agriculture, mining and transportation on a basis to meet the changed needs of the country. In short, it means the intelligent planning and execution of plans for a better community.

It is proposed that the National Committee on after-the-war conditions of the American Association of Engineers shall touch upon all lines of science, especially in their application to public welfare. The American Association of Engineers will do as much and more than it has done in the past in full support of the war, but it was the feeling of the directors that it is none too early to begin to plan for after the war. The American Association of Engineers now has 475 of its members in the service—20 per cent of its total membership.

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**Cost of Water Main Construction at Fall River, Mass.** During 1917 the Watuppa Water Board of the city of Fall River, Mass., laid 2,057 lin. ft. of 8-in. water mains. The pipe was put down in portions of 8 streets, in only one of which was rock encountered. In Tower St. 7 per cent of the excavation was rock. The unit cost of the work, according to the last annual report of the Water Board, was as follows:

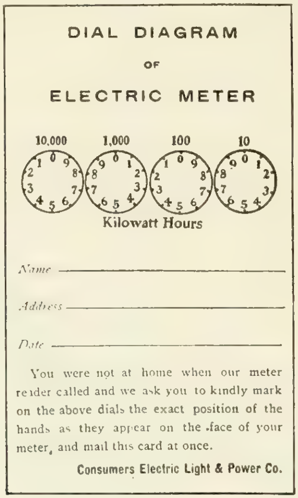
[illegible]

[illegible]

*[illegible] tion payroll

## Post Cards Save Return Calls by Meter Readers

In order to save the meter readers from the need of making return calls, the Consumers' Electric Light & Power Co. of New Orleans, La., has devised a delayed meter-reading post card. If when the meter reader calls he cannot get in, he leaves an addressed Government post card, on the reverse side of which is the information shown in the cut. The customer mails the card and is billed for the amount of energy shown to be used.


DIAL DIAGRAM
OF
ELECTRIC METER

10,000
1,000
100
10

Kilowatt Hours

Name

Address

Date

You were not at home when our meter reader called and we ask you to kindly mark on the above dials the exact position of the hands as they appear on the face of your meter, and mail this card at once.

Consumers Electric Light & Power Co.

Meter-Reading Post Card.

This system was put into effect in January of this year, and, according to the Electrical World, as early as May 75 per cent of the cards left were being returned to the company with readings indicated. In July General Manager W. J. Aicklen stated that through the use of post-card delayed-meter readings the company was effecting a saving of approximately $50 a month in meter readers' salaries.

## Water Towers and Standpipes

While a standpipe is well adapted to meet certain conditions, one of small diameter and large height is never satisfactory. The first metal structures built for the storage of water were standpipes only a few feet in diameter and of sufficient height to give, when filled, the pressure required. Such a design is uneconomical, as the amount of serviceable water stored in such a tank is only a small portion of the total capacity. The water below an elevation of 80 ft. is of little value for fire protection, and serves only to support the water above that point. Several times more water can be stored at an effective height for the same cost by a water-tower than by a standpipe. The tall cylinder of small diameter also has the great disadvantage of extreme variation in pressure between the time when it is full and empty. The water-tower and standpipe are not rivals, but each has its own distinct field of usefulness, states "The Water Tower," house organ of the Chicago Bridge & Iron Co.

A tank should be of sufficient capacity to store the water used during the hours when the pumps are shut down and also leave at all times sufficient water in the tank to supply one or more fire streams for a reasonable period of time. Fifty gallons per inhabitant, with a liberal allowance for an increase of population, should be the minimum capacity provided, and no tank for municipal service should hold less than 30,000 gal.

The height of the bottom of the tank should be at least 80 ft. above the ground level at all points where the fire protection is needed. It is, however, often possible to locate the tank on a natural elevation so that the water tower itself will not need to be 80 ft. high.

## Motor Trucks on Long Haul Garbage Collection at Los Angeles

Garbage collection from the outlying districts of Los Angeles, Cal., is handled by motor trucks. The full load haul ranges from 6 to 9 miles and averages about 8 miles. The cost per ton of garbage collected and hauled is $2.76. Two 2½-ton trucks collect about 300 tons of garbage per month. The operating cost of the trucks ranges from $210 to $250 per month, these figures including fuel, drivers' wages, repairs and depreciation. Garbage from these districts was collected formerly by 3-horse teams, each outfit making one round trip per day. In the short-haul zone, the garbage is collected by teams working in day and night shifts, the latter averaging 2,800 tons per month at a cost of about $1.18 per ton. The day shift collects about 2,200 tons per month at an average cost of $2.15 per ton.

## Making Pipe Joints in Wet Trench

Several thousand feet of 10-in. cast iron pipe for the new plant of Canadian Locomotive Co., Ltd., at Kingston, Ont., was laid in trenches 2 ft. to 4 ft. below water level, thus necessitating special precautions in making the joints and connections. At the joints the trench was enlarged and the pit sheeted, the pipe being brought through openings in the boards. The spaces around the pipe were sealed with clay, as was the bottom of the pits. The water in the pit was kept down by pump or siphon until the hub and spigot joints could be made. Practically the same method was employed in making the special connections. In these cases, however, the pits were 6 or 8 ft. square, and the pipes brought in through the sheeting were sealed by concrete. The bottom of the pit was covered with concrete in paper bags, rammed until often the bags were broken open.

**Coal Requirements of U. S. for 1918-19.**—An analysis of the country's coal needs for the current year, compared with the consumption of the previous year, compiled and made public on June 6, by the Government, shows the following:

| | Net tons coal | |
|---|---|---|
| Class of use | Required 1918-19. | Consumed 1917. |
| Industrial | 249,025,000 | 204,907,000 |
| Domestic | 75,678,000 | 66,915,000 |
| Gas and electric public utilities | 37,941,000 | 33,038,000 |
| Railroads | 166,000,000 | 155,000,000 |
| Exports | 24,000,000 | 24,000,000 |
| Beehive Coke | 52,450,000 | 52,450,000 |
| Bunker Foreign | 10,000,000 | 7,700,000 |
| Bunker—Domestic, inc. Great Lakes | 5,000,000 | 5,000,000 |
| Power and heat at coal mines | 12,500,000 | 11,000,000 |
| Substitution of coal for oil, mainly in the Northwest | 2,000,000 | ......... |
| Totals | 634,594,000 | 560,010,000 |
| Deduct: Imports | ......... | 907,000 |
| Deduct: Used from storage | ......... | 4,375,000 |
| Net tons of production | 634,594,000 | 554,728,000 |
| Increased requirements over 1917 | ......... | 79,866,000 |

## Condemns Sewage For Irrigating Vegetables

In the interest of public health the California State Board of Health has condemned the use of sewage or sewage-polluted water for irrigating garden vegetables, and it has also condemned the sale or consumption of vegetables so irrigated. The text of the board's resolution is as follows:

[illegible]

[illegible]

It is much better, states the Bulletin of the Board, that sewage should be used for promoting the growth of stock foods, fodder and crops harvested in the dry state, such as beans, alfalfa, seed corn, etc., rather than to take any risk of infection with typhoid or other diseases through the use of green vegetables or foods that have been irrigated with sewage.

## Personals

Arthur W. Jepson, for the past ten years superintendent of water works of Bristol, Conn., has resigned.

Kerth Maitland, assistant city engineer of Virginia, Minn., has [illegible] service.

[illegible] and [illegible] in the engineering corps of the Army.

[illegible] Fredericksburg, Va., has been commissioned a first lieutenant in the engineering corps of the army.

George Wilbur Hubley, former superintendent of the Louisville Gas and Electric Co., has been appointed administrative engineer of the Federal Fuel Administration of Kentucky.

Carleton Scott has resigned as superintendent of water works of [illegible] He [illegible]

Finlay L. MacFarland has been elected president of the first Board of Water Commissioners of Denver, Colo. Charles H. Reynolds was elected vice-president and Benjamin A. Sweet secretary.

William M. Faber of Cleveland, O., has been appointed by M. S. Hopkins, administrative engineer of the State Fuel Administration, to represent him in seeing that industries of northern Ohio obey rules of the fuel administration.

L. S. Hulburd, senior assistant engineer at the Lyons, N. Y., [illegible] U. S. A. C. V. O'Malley, junior assistant engineer in the same office, has received a lieutenant's commission.

Miss Zelma Zentmire, formerly instructor in hygiene in the [illegible] man, Jr., who has entered the Sanitary Corps of the Army.

Robert W. Gay, who for the past eight years has been professor of civil engineering at the Mississippi Agricultural and [illegible] engineer with the Morgan Engineering Co., of Memphis, Tenn.

H. F. Cameron, manager for the Lake Charles Railway, Light & Water Works for the last three years, has resigned to accept the position of consulting engineer with the Union Sulphur Co. Mr. Cameron was formerly connected with th Westinghouse Co. at [illegible]

[illegible] recently.

[illegible] of Purdue Univer[illegible]

[illegible] of Illinois, and Dr. H. W. Nich[illegible] tion of the Am. Soc. M. E., were [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] had all retreated from the south bank of th[illegible] that such was not the case, they were th[illegible] less, such was his bravery and determinati[illegible] across the River Vesle, near Fismes. H[illegible] heavy shell fire and was frequently [illegible] our farthest lines and secured the [illegible] had been [illegible] by [illegible] sible sites for pontoon [illegible] structures. Despite h[illegible] acting entirely without ord[illegible] reconnoissance a complete s[illegible]

## Obituaries

[illegible] of Peoria, Ill., died Sept. 1 at his home in that city, [illegible]

[illegible]

[illegible] ton, Tex., died Aug. 29 at Beaumont, aged 42.

Thomas Mason, general superintendent of the New York Ship[illegible]

[illegible]

[illegible]

## Industrial Notes

[illegible]

[illegible]

# Bids Asked

## Roads = Streets

**Ida., Boise**—Until 2 p. m., Sept. 16, by State Highway Commission, W. T. Dougherty, secretary, for constructing approximately 22 miles of north and south highway between the Salmon river, near Whitebird and Grangeville, in Idaho county. Proposals will be received as follows: for the grading and surfacing as required; for the bridges and concrete culverts and for the corrugated iron pipe necessary for culverts. State Highway Engineer, Boise, and Division Engineer at Lewiston, Idaho.

**Ind., Bloomfield**—Until 2 P. M., Oct. 8, by Commissioners of Greene County, for the construction of two macadamized roads in Jefferson and Fairplay Twps. Geo. E. Kidd, County Auditor.

**Ind., Fort Wayne**—Until 7:30, Sept. 19, by Board of Public Works, for approximately 1,010 lin. ft. of pipe railing in place, on and along the retaining walls of the Coombs St. subway.

**Ind., Fort Wayne**—Until 7:30 p. m., Sept. 19, by Board of Public Works, H. W. Becker, clerk, for construction of following improvements: For grading roadway on French Ave., from Hoagland Ave. to Fairfield Ave.; for grading roadway on Hoagland Ave., from Arcadia Ct. to Sudisili Blvd.; for grading roadway on Dayton Ave., from Fairfield to S. Wayne Aves. and from Indiana to Beaver Aves.; for grading roadway on Short St., from Archer to Pfeiffer Aves.

**Ind., Greenfield**—Until 10 A. M., Sept. 27, by Commissioners of Hancock County, for the construction of a gravel road in Brown. Twp. Harvey J. Rhue, County Auditor.

**Ind., Indianapolis**—Until 10 a. m., Sept. 27, by Commissioners of Marion County, for the construction of a concrete road in Center Twp. Leo K. Fesler, County Auditor.

**Ind., Indianapolis**—Until 10 a. m., Sept. 27, by Commissioners of Marion county, for the construction of a concrete road in Center twp. Leo K. Fesler, County Auditor.

**Ind., Muncie**—Until 10 a. m., Sept. 14, by Commissioners of Delaware county, for the construction of a gravel or macadam road in Washington twp. F. M. Williams, County Auditor.

**Ind., Muncie**—Until 10 a. m., Sept. 14, by Board of Commissioners of Delaware County, for the improvement of highways in said county, by grading, graveling or macadamizing said highway known as L. A. Couse road in Washington twp. Francis M. Williams, Auditor, Delaware county.

**Ind., Noblesville**—Until 10 a. m., Sept. 28, by Commissioners of Hamilton County, for the construction of a gravel road in Washington Twp. H. O. Cottingham, County Auditor.

**Minn., Aitkin**—Until 10 a. m., Sept. 14, by John Wiebel, Town Clerk, for constructing approximately 5.6 miles of road.

**Minn., Glencoe**—Until 2 p. m., Sept. 21, by F. D. Stocking, County Auditor, McLeod County, for constructing Federal Aid Project No. 34, State Road No. 5, approx. 13.17 miles in length, involving 5.25 acres grubbing; 57,987 cu. yd. excav.; 2,928 cu. yd. hand ditching; 550 lin. ft. guard rail; 25 cu. yd. concrete end walls, also installing and furnishing section concrete culvert material as follows: 910 lin. ft. 12-in.; 327 lin. ft. 15-in.; 35 lin. ft. 18-in.; 34 lin. ft. 24-in.; 70 lin. ft. 36-in.; 15,840 cu. yd. graveling surfacing material; Bridge No. 2914, 10-ft. span; 12 reinf. concrete culverts; 14 concrete culverts.

**Minn., Winona**—Until 2 p. m., Sept. 26, by Adolph Baeuerlen, County Auditor, Winona County, for constructing Federal Aid Project No. 8, State Road No 18, approx. 6.42 miles in length, involving 4.9 acres clearing and grubbing; 39,842 cu. yd. earth excavation; 7,141 cu. yd. solid rock excav.; 180.8 cu. yd. culvert end walls; also installing and furnishing section concrete culvert material as follows: 140 lin. ft. 12-in.; 622 lin. ft. 18-in.; 370 lin. ft. 24-in.; 65 lin. ft. 30-in.; 55 lin. ft. 36-in.; 65 lin. ft. 48-in.; Bridge No. 2949, 10-ft. extension of cattle pass, Bridge 2865, 30-ft. span reinf. concrete; Bridge 2866 30-ft. span, reinf. concrete; W-46x24 ft. reinf. concrete culvert. Total estimated cost $34,019.

**Ore., Portland**—Until 10 a. m., Sept. 12, by L. I. Hewes, Dist. Engineer, Bureau of Public Roads, Dept. of Agriculture, Portland, for constructing or improving the Republic-Wauconda Nat'l Forest Road project located within the Colville Nat'l Forest, Okanagon County, State of Washington. Approximately 3.4 miles in length, involving 14 acres clearing and grubbing; 26,000 cu. yd. common excav.; 5,000 cu. yd. rock excav.; 1,200 station yd. overhaul; 1,150 lin. ft. log culverts; 325 cu. yd. dry rock retaining wall, and 400 lin. ft. guard rail.

**Pa., Greensburg**—Until noon, Sept. 30, by John S. Sell, County Controller, for the construction of the following named county roads: Webster-Pittsburgh-Uniontown Pike Road, 1.79 miles in Rostraver twp, 16 ft. wide over all, with concrete base and curb and brick surface. Fort Robertson-School House-Yukon road, 3.22 miles in South Huntington Twp., 17 ft. wide over all, with slag base, concrete curb, and brick surface.

**Pa., Harrisburg**—Until 10 a. m., Sept. 25, by J. D. O'Neil, State Highway Comr., for the reconstruction of 1,115 lin. ft. of either vitr. block pavement or bituminous concrete on a concrete foundation, from 20 to 34 ft. wide, Yeadon borough, Delaware County, route 130; also 5,091 lin. ft. of 1-course plain cement concrete pavement, 18-ft. wide, Ligonier borough, Westmoreland County, route 119.

**Wis., Milwaukee**—Until 10:30 a. m., Sept. 14, by Board of Public Works, Percy Braman, Deputy Comr., for improving 51st St. from north line of Elm St. to south line of North Ave. in 22nd ward.

## Bridges

**Calif., Modesto**—Until 10 a. m., Sept. 12, by Board of Supervisors of Stanislaus county, for construction of a reinf. concrete arch bridge over Orestimba creek, about 2½ miles east of Crown Landing; also one reinf. concrete arch bridge over Orestimba creek, 4 miles east of Crows Landing, and one reinf. concrete girder bridge over Kings River and San Joaquin Irrigation Company's canal about 1 mile west of Newman. H. Benson, County Clerk.

**Calif., Santa Barbara**—Until 10 a. m., Sept. 16, by Board of Supervisors of Santa Barbara County, for furnishing all material and labor and constructing reinf. concrete bridge, deck and rails to said bridge located on River Rock road, in the 2nd road district. Santa Barbara county. C. A. Hunt, Clerk of Board and County.

**Calif., Santa Barabara**—Until 10 a. m., Sept. 16, by Board of Supervisors, for furnishing all labor and material and constructing reinf. concrete bridge with abutments and wing walls over Romero creek, on Sheffield Drive, bet. San Leandro Lane and the Coast Highway, in the 2nd road district, Santa Barbara county. C. A. Hunt, County Clerk.

**Calif., San Jose**—Until 11 a. m., Sept. 16, by Board of Supervisors, Santa Clara County, for the construction of a reinf. concrete bridge on Kirk Road and Luther Ave. over Ross Creek in Supervisor Dist. No. 4. Also for the construction of a reinf. concrete bridge on Congress Springs Rd., in Dist. No. 5. Henry A. Pfister, Clerk.

**Ill., Benton**—Until 1 p. m., Sept. 16, by Dept. of Public Works and Buildings, Div. of Highways, Springfield, for constructing one reinforced concrete bridge in Benton twp., Franklin county—Martin Bridge, 20-ft. span; 20-ft. roadway; 8½ ft. height over all. 54.1 cu. yd. concrete, reinforcing steel 4,760 lbs. Estimated cost $1,300. Also one reinforced concrete bridge in Barren twp.—Quillman Bridge, 30-ft. span; 16-ft. roadway, 11 ft. height over all. 69.2 cu. yd. concrete, 8,990 lbs. reinf. steel. Estimated cost $2,200. W. E. Moore, County Supt. of Highways, Benton.

**Ill., Carthage**—Until 1 p. m., Sept. 14, by Dept. of Public Works and Buildings, Div. of Highways, Springfield, for constructing 5 reinf. concrete culverts on the highway between Terre Haute twp., Henderson county, and LaHarpe twp., Hancock county—Belknap, Edmonds, Edmonds No. 1, Newt. Marshall and Melvin bridges: Spans 2½, 5, 5, 5, and 4 ft., roadways 24, 20, 20, 20 and 20 ft.; heights over all, 8, 7½, 7½, 11 and 8 ft. Estimated total concrete, 11.6, 18.6, 18.6, 26.9 and 23.2 cu. yd.; reinforced steel, 55, 1,230, 1,230, 1,840 and 1,930 lbs. Engineer's estimate on 5 culverts, $2,320. Also two reinforced concrete culverts on highway between Lomax Twp., Henderson County, and Durham Twp., Hancock County—Wm. Dean, No. 1 and No. 2 bridges; spans, 2½ ft.; roadways, 20 ft. on top of fill; heights over all, 13 ft. Estimated total concrete in each culvert, 11.6 cu. yd.; reinforced steel, 1,160 lbs. Estimated cost, $600. Wm. Burgner, County Supt. of Highways, Carthage.

**Ill., Chicago**—Until 11 a. m., Sept. 18, by Board of Local Improvements, Edw. J. Glackin, Secy., room 207 City Hall, for furnishing all labor and material for construction of all work, including electrical conduits for the substructure of the North Approach, being the improvement of N. Michigan Ave., from Ohio St. to the first expansion joint north of the north plaza and including the improvement of Grand Ave. from Rush to St. Clair Sts., and the readjustment and improvement of all streets and alleys intersecting and abutting said improvement.

**Ill., Marion**—Until 2 p. m., Sept. 14, by Department of Public Works and Buildings, Springfield, for constructing one reinforced concrete bridge in Lake Creek Twp., Williamson County—Scott Harris bridge, 16-ft. span, 16-ft. roadway, 13 ft. height over all, 57.5 cu. yd. concrete, 5,080 lbs. reinforcing steel. Estimated cost, $1,700. P. B. Wilson, County Supt. of Highways, Marion.

**Ill., Nashville**—Until 3 p. m., Sept. 12, by Department of Public Works and Buildings, Division of Highways, Springfield, for constructing one reinforced concrete box culvert in Ashley Twp., Washington County—Koenigsmark bridge, 10-ft. span, 2¾-ft. clearance, 18-ft. roadway, 25.7 cu. yd. concrete, 2,420 lbs. reinforcing steel. Estimated cost, $635. Also three reinforced concrete box culverts in Hoyleton Twp.—bridges Nos. 12, 13 and 14: Spans 10, 3 and 6 ft.; height over all, 9, 6 and 7 ft.; roadways, 18, 20 and 20 ft. Estimated total concrete, 34.6, 7.6 and 16.1 cu. yd.; reinforcing steel, 2,860, 580 and 1,300 lbs. Engineer's estimate, $1,465. O. C. Ravenneck, County Supt. of Highways, Nashville.

**Ind., Fort Wayne**—Until 10 a. m., Sept. 18, by Board of Commisisoners, Allen County, for repair and creosote block floor of the Butt bridge in Maumee Twp. and for furnishing material for said bridge. Will Johnson, Auditor, Allen County.

**Ind., Winchester**—Until 10 a. m., Sept. 26, by Commissioners of Randolph County, for the construction of bridges in White River, Ward, Franklin and Washington Twps., five in all, and repair all others. C. E. Tillson, County Auditor.

**Mass., Boston**—Until 12 noon, Sept. 12, by Thos. F. Sullivan, Commissioner of Public Works, 511 City Hall Annex, for building additions to abutments of the N. Y., N. H. & H. Ry. near Dorchester Station, and a concrete retaining wall adjoining the western abutment.

**Ohio, Hamilton**—Until 10 a. m., Sept. 25, by Board of Butler County Comrs., W. W. Crawford, Clerk, for the construction of a concrete steel bridge at the Frend-Crout farms, on the Montgomery-Butler County line, Madison Twp., Sec. 28, and Gratis Twp., Sec. 28.

**Pa., Greensburg**—Until noon, Sept. 24, by John S. Sell, County Controller, for the construction of a 35-ft. clear span, 20-ft. over all roadway, reinf. concrete bridge, including wing and abutment walls, floor system and parapet walls and necessary approaches over Chartiers Creek in Lower Burrell Twp ¾ mile from where said creek empties into the Allegheny River, and located on New Kensington-Edgecliff road.

**Pa., Harrisburg**—Until 10 a. m., Sept. 23, by Henry W. Gough, County Controller, Room 13, Courthouse, Harrisburg, for the

*Railways and Government Works*
*Monthly Issue*

ENGINEERING AND CONTRACTING

Halbert P. Gillette, *President and Editor* — Lewis S. Louer, *Vice President and General Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering field. See advertising page [illegible]

**Roads and Streets—1st Wednesday**
[illegible]

**Waterworks and Hydraulics—2nd Wednesday**
[illegible]

**Railways and Govt. Works—3rd Wednesday**
[illegible]

**Buildings and Structures—4th Wednesday**
[illegible]

Volume L. — CHICAGO, ILL., SEPTEMBER 18, 1918 — Number 12

# Have Public Service Commissions Proved to Be a Failure?

The regulation of railway and public utility rates by public commissions has thus far not been the unqualified success that was anticipated by its advocates. It is the consensus of opinion among business men that the Interstate Commerce Commission failed to give the railways adequate rate increases, and thus brought the finest railway systems in the world to the verge of financial starvation. The same thing has happened to most of the street railways, and for the same reason.

After the tardy granting of a 15 per cent raise in freight rates by the I. C. C., the government took hold of the railways and immediately raised rates 25 per cent more. Yet this is proving inadequate to make both ends meet, in spite of great increases in traffic.

Street railway companies have appealed to the federal government for rate increases, as they face ruin without such relief.

The state of Massachusetts has just passed what has been called "an epoch-making law," providing for a new form of public control of the Boston Elevated Railway by the state. The State Public Service Commission, after 47 years of control of public carriers, is virtually declared worthless, and a radically new plan of control is introduced. Under this new plan the stockholders of the Boston Elevated Railway are guaranteed certain percentages (up to 6 per cent) on the par value of their securities. The company is to be managed by five trustees appointed by the Governor, these trustees having the power to regulate rates so as to insure the guaranteed return on the stock. There is no "water" in the stock.

Such facts as these point unmistakably to some grave defect in the personnel of most public service commissions, or in the laws under which they operate, or both. It is our opinion that all the laws and many of the commissioners are faulty. To begin with, public service commissioners should be appointed for life, and should not be allowed to become candidates for public office for at least two years after resigning a commissionership. In no other way can insurance be universally secured against the influence of political ambition and a desire to please the public at the expense of the utility companies. The besetting fault of most commissions has been the very natural desire to secure public applause. This alone has sufficed to prevent independent, fair action on the part of scores of commissioners.

The laws should specify the qualifications of the commissioners in order to insure, as far as practicable, that experienced and well trained men shall be appointed to commissionerships. Certainly at least one member of every commission should be an engineer, and one should be a lawyer.

The law should provide for a sliding scale of dividends dependent on the efficiency of management of the company. For if dividends are limited to a fixed percentage on the investment, most of the incentive to economic management vanishes. The new law under which the Boston Elevated Railway is to be operated is very defective because it fixes the dividends.

We believe that all net earnings in excess of, say, 6 per cent on the investment in the plant, should be equally divided between the company and the public treasury, after the plan that has worked so successfully with the Chicago street railways. In this way the public secures the benefits of public ownership, yet without buying the plant, and coincidently it keeps the street railway out of politics.

Up to the present, engineers as a body have given no attention to the laws under which public utility commissions operate. There are few more important public questions than this one of the control of public utilities. Aside from engineers, no one has done much toward a scientific solution of rate problems. There are hundreds of engineers qualified to give expert advice to engineering societies as to the best general methods of regulating public utilities, both as to rates and as to service. Engineering societies should secure the advice of such men and then take active steps to effect an entire revision of public service commission laws in every state in America.

# Reducing the Peak Load of Street Railways by Staggering the Business Hours

The economic principle of securing a higher "load factor" and reduced "peak load" has seldom received adequate study except in a few industries where engineers have had a voice in the management. In the generation and sale of electric energy, engineers have long enjoyed the confidence of the operating heads of the electric companies, and engineers have frequently been the operating heads of such companies. Consequently electric companies have learned the economic importance of high load factors. A load factor is the ratio of the actual output to the full capacity output of a plant.

In street car service the load factor has always been extremely low, because of the very high peak loads for a short time in the morning and early evening. To reduce these peak loads, two methods have been recently devised: (1) The staggering of the working hours in industrial establishments, and (2) the encouragement of the custom of shopping during the "off peak" or non-rush hours of the day. In Rochester, N. Y., a central committee of citizens induced manufacturers and others to stagger their hours of opening and closing, and this immediately relieved the congestion of street cars enormously.

A committee of engineers reported not long ago to the War Board of the American Electric Railway Association that a marked increase in the efficiency of the street railways in Washington, D. C., could be effected by staggering the office hours of the 50,000 Government employes. At 4 p. m., 155 cars handle the traffic, but an hour later 545 cars are required and they are jammed full. The suggestion was made that the offices should be divided into four groups, the first group being opened at 8:30 a. m. and the other groups at intervals of 15 minutes.

The staggering of business hours not only results in better service with fewer cars, but it effects a substantial reduction in fuel. In Rochester the increased load factor resulting from staggering the hours, coupled with more systematic coaling of the car heaters, effected a saving of 17 per cent of the fuel, or 100 tons daily. This was accomplished without the "skip stop" plan, which will probably effect a further saving of 10 per cent.

Important as fuel saving is, it is of minor consequence compared with the reduced number of cars and the reduced size of the electric power plant needed when the peak load has been cut down.

Civil engineers should give careful thought to every innovation that lowers a peak load, for the greater number of such examples stored in the memory the greater the likelihood that an engineer will see new opportunities to apply this economic principle.

Some years ago we called attention to the application of the load factor principle by the telegraph companies when they introduced the "night letter" plan of sending 50 words at the day rate price for 10. This plan greatly increased the net earnings by securing "off peak" business that could not have been obtained otherwise. Possibly our street railways will ultimately adopt a similar plan to encourage shopping during "off peak" hours. Thus if 6 ct. is the normal fare, a 4 ct. fare during the hours of 10 a. m. to 3 p. m. would doubtless increase the transportation at a time of the day when both the merchants and the street car company would welcome an increase in their "load." The Bay State Street Ry. is the first to have introduced a reduced rate for off-peak riding. It is not risking much to prophesy that the plan will be a success and will be adopted eventually by most of the street railways in America.

# Why Engineers Should Prepare Revisions of Public Utility Laws

The day will come—let us hope that it will be soon—when we can turn to periodicals devoted to the operation of steam and electric railways with an assurance of finding more space devoted to the economics of operation and less to rate cases and Government control. During the past 10 years a steadily increasing volume of editorial and other articles relating to state and Federal regulation has been printed in railway magazines. Indeed, the editors of some of these periodicals have reached a point where they can write of little else than about the relations of the transportation companies to the public. Yet in spite of all this publicity, engineering societies have taken very little active interest in the tremendously important problems involved in Government control of railways. True, there have been published in society transactions hundreds of papers and committee reports on the technicalities of appraisals and ratemaking. But is it not highly significant that not a single engineering society committee has ever reported on the laws that provide for the regulation of public utility companies? Does not this fact alone show how slow engineers have been to recognize their full public duty?

Accustomed to regard law making as being entirely within the province of legislators and lawyers, engineers have not generally realized that they are more competent to draft laws relating to public utility service and rates than are any other class of men. Engineers have both the scientific and the economic knowledge essential in writing laws that are to govern the correct application of engineering and economic science in determining rates of charge and character of public utility service. Other men, with a few individual exceptions, are not thus qualified.

It is now becoming evident to the public itself that something is wrong with its public service commission control of method of utility regulation. As noted in another editorial, the state that first introduced commission control of public utilities, Massachusetts, has virtually repudiated the plan. Not only has Massachusetts evolved an entirely new plan for the largest street railway system in Massachusetts, but the General Court (Legislature) has provided for several other distinct plans for other traction lines. Harlow Clark, in the June issue of "Aera," said:

> It is scarcely too much to say that the theory of state regulation of electric railways has, by these acts of the General Court, been relegated to the past so far as Massachusetts is concerned. The supervision of nearly one-half of the mileage of the commonwealth has been removed entirely from the Public Service Commission, except as to some unimportant details, and the power to regulate rates for the remainder of the properties has been taken from it, except in the case of railways, which may not elect to come under the provisions of the cost of service act.

We are not of the opinion that public service commission regulation of public utilities has failed completely, nor do we look for a general abandonment of the public service commission plan. But we do look to see radical changes in the laws under which these commissions operate. Now is the time for engineering societies to study these laws with a view to bettering them. Then, having prepared a standard or model bill, engineering societies should seek the aid of chambers of commerce and other associations in securing its enactment into law in every state.

## Lane Says the Government Should Own the "Standardized" Industries, But Where Are They?

Franklin K. Lane, secretary of the interior, seldom speaks injudiciously; but, being a lawyer, it can scarcely be expected that he will always speak wisely on matters involving economics. At the annual convention of the U. S. Chamber of Commerce he talked inspiringly on the New Democracy. But he evidently indorsed Government ownership of certain public utilities on the ground that they have become "standardized industries." He said:

> [illegible] is rare; that governmental methods are wasteful; that there are things which have been standardized which can safely be left to the hands of government, but that, above all, we must save personal initiative, the inventive power of the human mind. But where a point of standardization has been reached in an industry, why should not government take that industry into its own hands [illegible]

Read again those last two sentences and weigh their pvrport. Our Government has temporarily taken over the steam railways and the telegraph ana telephone lines. Now if it were planned to retain them permanently what better major premise could be formulated for an argument in favor of Government ownership than the one involved in that next to last sentence? The syllogism then would be:

Every completely standardized industry should be owned by the Government.

American railways are a completely standardized industry. Hence American railways should be owned by the Government.

Both the major and the minor premise sound plausible, and, if granted, the conclusion inevitably follows. But neither premise should be admitted without proof. First, we should inquire what is meant by the expression "standardized." Apparently Mr. Lane has in mind a plant that is susceptible of no further economic improvement through invention and the initiative of men acting under the inducement of personal profit; for he couples the statement that "governmental methods are wasteful" with the statement that "we must save personal initiative and the inventive power of the human mind." Apparently Mr. Lane thinks that some industries have reached a condition of complete "standardization," and apparently he means by that a condition where neither personal initiative nor invention can accomplish much further improvement. Does he have in mind the railways? If so, he has very little idea of the economic progress of railway transportation in recent years, and of the enormous potential progress when adequate capital is made available through an insurance that all the increased profits will not be seized by the public.

Mr. Lane's greatest mistake lies in the assumption that any industry will ever become so completely "standardized" that it will cease to improve economically under the influence of invention and the incentive of further profit. Yet his error is not uncommon among men who lack scientific training and experience in applied technology.

A public service commissioner not long ago asked an engineer witness how it was that if engineers struggled constantly toward the goal of perfect economy they would not some day reach the goal. The commissioner was a keen lawyer, a man of learning and common sense, yet it was difficult for him to see the false analogy between the fixed goal in a game of skill and the constantly receding "goal" in the great game of applied science. Probably he could not have understood the deep significance of Isaac Newton's remark about scientific knowledge: "I feel like a boy who, having gathered a few pebbles from the ocean's shore, contemplates the vastness of what he does not hold."

## Economic Problems Should Not Be Submitted to Popular Vote

To submit economic problems to the general public for solution is quite as foolish as it would be to permit voters to decide how General Foch should solve the military problems that confront him. Yet this sort of folly is still prevalent, particularly in municipal governments. For example, after the Oregon Public Service Commission had ordered a 6 ct. street railway fare in Portland, the people voted, two to one, to permit jitneys to compete with the street cars; the obvious object being to nullify, as far as possible, the attempt of the Public Service Commission to give financial relief to the street railway company. An ignorant public takes a hand in an economic problem and exercises the "inalienable right of American citizens" to decide upon matters that can only be decided fairly and properly by economic experts who have nothing personally at stake.

## Increased Fares for Street Railways

The citizens of Sioux Falls, S. D., have permitted the street railway to increase its fare to 6 ct. This is the first time that a higher street car fare has been secured by a referendum vote. It is significant in that it shows a public disposition to grant increased rates to a public utility company when public sympathy is aroused by evident increases in prices of materials and wages. Several cities in New York state have shown a similar disposition. Following a decision of the state supreme court that where a franchise limits the fare to 5 ct. the Public Service Commission can not raise it, the city council of Syracuse decided not to oppose the 6 ct. fare granted by the Commission; and several smaller cities have shown a similar attitude.

In about 100 cities either a 6 ct. fare or a "zone fare" has already been put into effect, the largest city being St. Louis and the next largest being Pittsburgh.

Probably the most effective reason for granting higher fares has been the rise in wages. This is a factor that the public can understand and one that arouses its sympathy. When the employes of a street railway company petition a city council, as they recently did in Philadelphia, to grant a 6-ct. fare so that the company can raise their wages, there is apt to be favorable action by the city council.

In spite of the voluntary granting of increased fares to companies by cities, in many cases, sight should not be lost of the fact that neither the general public nor a city council is a proper tribunal to decide rate cases. A rate case usually involves so many economic factors that no one but an expert can be relied upon to interpret all the factors correctly. If every rate case were decided by a board of appraisal and rate engineers, there would be few instances of injustice either to the public or to the companies.

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## The British Engineering Review Issue of E. and C.

To the Editor: I wish to congratulate the management of "Engineering and Contracting" for the excellent British Engineering Review number issued July 31, 1918.

It is not often that American engineers are privileged to find out as much regarding the practice in foreign countries. The number is timely on account of the very great interest of Americans in European affairs.

As one of your readers, I sincerely trust you will find your way clear to illustrate the engineering practice in other foreign countries.

I extend my best wishes for the continued success of "Engineering and Contracting."

D. J. Brumley,
Valuation Engineer,
Illinois Central R. R.
Chicago, Ill.

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## Cleaning Soot from Smoke Stacks with Blasting Powder

A simple method of cleaning out soot from large smoke or kiln stacks consists in shooting the stack with a special type of gun and FFF blasting powder. It is stated that this method can be used in cleaning either lined or unlined stacks, brick or steel, without any fear of injury to either the stack or the lining.

The gun can be made out of an old piece of shafting about 4 in. in diameter and 14 in. to 16 in. long. Bore a hole 1¾ in. in diameter and 10 in. long in the center of the piece. Then bore a small horizontal hole ¼ in. in diameter through the piece to the bottom of the center bore. This hole serves as a touch hole for inserting the fuse. The whole thing can be mounted on a pedestal about 6 in. in diameter so that it will stand in an upright position.

The method of operation is as follows: Pour some FFF blasting powder into the mouth of the cannon to about 2 in. from the top. Tamp to the collar with dry clay. A short piece of fuse is inserted in the touch hole and in contact with the main powder charge. Open the flue door at the bottom of the stack, set the cannon on the bottom and in the center of the stack, light the fuse and close the flue door.

The explosion shakes and loosens the soot adhering to the sides, causing it to fall to the bottom. It can then be removed through the flue opening.

A charge of 8 in. of FFF powder, 1¾ in. in diameter, is sufficient for a stack up to 100 ft. high and 4 ft. in diameter, or over. The number of shots necessary to thoroughly clean a stack depends upon its condition. Ordinarily three or four shots will clean a stack but if very dirty it may require more. The size of the charge and length of the cannon can be regulated to suit the height and diameter of the stack.

One of the largest manufacturing concerns in the country has used this method for several years, without an accident or injury in any way to the stacks.

## Sanitation of Construction Camps

In these days of military activity, with soldiers widely scattered throughout the land, a camp is naturally conceived of as having to do with war, and relatively little thought is given to those gatherings of men who are occupied with the activities of peace. There are, however, certain well defined differences between labor camps and those of soldiers, the most notable of which is the existence of military authority in the one and its entire absence in the other. This point is brought out by Dr. W. P. Mason, Professor of Chemistry, Rennsselaer Polytechnic Institute, in a paper presented at the annual meeting of the Franklin Institute. In his paper, an abstract of which is given below, Dr. Mason discusses various methods for the sanitation of construction camps, and describes several devices developed by the army that are applicable to labor camps.

Of all the forms of danger which may accompany camp life, that arising from the presence of human dejecta is the one requiring the most serious consideration. How shall this material be handled so as to deprive it of power to become a menace to health? Even when the number of men employed on the job is small, it will never be wise to allow them free license to act as they see fit in the matter of disposing of their bowel discharges. This is particularly true if the job be one involving the possible pollution of a public water supply.

**The Straddle Trench.**—So simple a device as a "straddle trench" is quickly made and easily cared for, and, if well located, possesses the advantage of placing the material collected in a portion of the soil where pathogenic bacteria will find conditions least likely to favor their longevity.

A straddle trench should be dug 12 in. wide, 12 in. deep, and as long as circumstances demand. Dejecta placed therein and covered at once with the excavated earth will be quickly destroyed, in contrast with what happens to it when deposited in pits many feet deep. In the latter case the action is one of imprisonment rather than destruction.

It would seem scarcely necessary to urge attention to the selection of a proper site for a straddle trench, and yet it was lack of good judgment in such a matter that caused an outbreak of typhoid fever in a New England community through the washing out by heavy rainfall of dejecta carelessly buried on a steep hillside.

No more safe method of disposal for small amounts of night soil can be secured than placing it in small lots just under the surface of the ground in a level sandy loam. It is the privy system at its best.

**New Railroad Device and the Privy System.**—A device has been under trial by one or more railroads whereby a certain speed has to be attained by the car before the toilet pans can be dumped. While the train is standing at stations or while it is slowly approaching or leaving them the pans are automatically locked. The advantage, so far as cleanliness of the station is concerned, is apparent, but benefit reaches further than that, for the reason that the material discharged at a high rate of train speed is spread over much ground, which increases the opportunity for natural purifying agencies to do their work.

A simple, old-fashioned privy system is often the only one which will fit camp conditions, but deep pits are then usually a necessity. Flies must be absolutely excluded from the possibility of reaching the excreta, seat-covers must always be provided, and must be so constructed as to be self-closing when the seat is vacated, and the ventilating window must be screened. The seat-box should be movable to allow of the pit being burned out with straw and oil three times a week, if not oftener.

As camps grow in size, the labor of properly caring for them increases. Men have to be employed whose entire time is devoted to sanitary work. Proper water carriage of sewage, night-soil removal, and incineration of garbage are matters that fall under the care of such men.

A complete water-closet system contemplates sewers and also a disposal plant, unless there be available either some large body of water into which raw sewage can safely be discharged, or else an almost unlimited area of suitable sandy soil for disposal by irrigation. At one of our cantonments where some thousands of men are collected, the raw sewage, after coarse screening, is run into a blind ditch in the sand which ditch is simply extended as its side slopes and bottom becomes clogged. Clogging is delayed by suitable use of a rake. Nothing could be simpler, but the character of the soil requisite for such a solution of the sewage problem is rarely found, and when found cannot be unduly overworked.

Night-soil removal, or the can system, involves burying the can contents or else burning them, and the decision is sometimes in favor of employing both methods, although burying is the more common.

**Incinerators.**—For a simple device, calculated to provide for a reasonable number of men, and especially suitable for garbage destruction, the Woodruff pit is worthy of attention. It is merely a circular hole in the ground, 10 ft. in diameter and about 4 ft. deep, with the sides lined up with field stones. In the center is a conical pile of the same stones to act as a sort of draft chimney. This pile can be advantageously supplemented by a couple of lengths of the pipe, or even old stovepipe. A good fire of wood having been started in this pit, a very considerable amount of camp refuse can be disposed of by judicious firing. Liquids should be slowly poured down the hot side stone so as to encourage rapid evaporation. If liquids be added in too great bulk or thrown on too quickly they are likely to pass the fire zone and reach a lower level where they may start a nuisance.

One disadvantage of the Woodruff pit or of any other type of open fire is that when the wind is high, light materials will often be blown about the camp; this is especially objectionable if these materials chance to be what are known as "camp butterflies," or toilet paper.

Urine can be well disposed of by the stone-filled soakage pits, adopted by the British Army, into which long funnels of wood or tin are extended. Fouling of the ground with consequent fly infection is thus avoided.

At one large New York camp a non-portable furnace was built which worked successfully. It consisted of three levels, of which the bottom one held the fire. The top level was a shelf extending from the front half-way or more toward the back wall, and upon this shelf was thrown the material to be destroyed. The middle level was also a shelf of about the size of the top one, but it extended from the back wall out toward the front. Thus the hot products of combustion followed a curved course under and over the materials on the two shelves. When the charge on the top shelf had become thoroughly dried it was pushed back so as to fall on the middle shelf, and when it had thoroughly charred in that position it was pulled forward and fell upon the fire.

**The Plattsburg Furnace.**—A military furnace developed at Plattsburg is operated without drying shelves. Its length is greater than its height, and the garbage charge is dumped directly upon the fire through a trap-door. The fuel is cordwood. Around the sides of the combustion chamber run iron water pipes that act like the water-back of a kitchen range and supply hot water with which to wash the cans in which the garbage is collected. The process is not continuous, and a new fire has to be started every morning.

While garbage is usually incinerated in a furnace such as this or in a Woodruff pit or in some still simpler arrangement burning either wood or coal, yet it generally contains so much combustible material that a device less costly in the matter of fuel consumption is to be preferred.

The Canadian camps, or at least some of them, are using a furnace which is designed to operate continuously without any other fuel than that contained in the garbage itself after an initial fire of wood has been built as a starter.

Excellent results have been secured in France by constructing incinerator walls out of old oil cans filled with puddled clay. After a wall built in such a manner had been fired it proved very stable. Similar cans used empty produced a reliable chimney, and old railroad iron thrust irregularly through the furnace walls supplied supports for the garbage charge and permitted air to reach scattered points throughout the mass.

It has been found of advantage to follow the introduction of old tin cans of every description into the furnace with the garbage, as thereby a desirable "porosity" was given to the material being burned.

Horse manure can be burned by arrangement such as just described, but the destruction of valuable fertilizing material savors of decided waste, and, moreover, a labor camp rarely contains enough horses to demand military measures. Fifty horses will make about a wagonload of manure daily, but however small the volume may be, provision must be made to prevent its becoming a breeding place for flies. Usually, although not always, farmers are found willing to cart manure away for use upon their crops, in which case it is of interest to be certain that it is hauled to a sufficient distance before it is piled; otherwise, as a large camp presents many attractions for flies, the insects are likely to find it if the haul should be a short one.

## Division of Inland Waterways Created

The administrative supervision of waterways has been placed under the control of the United States Railroad Commission. G. A. Tomlinson has been appointed director of the new division which will be on an equal plane with the other principal divisions of the Railroad Administration. Under Mr. Tomlinson's general direction will be the Erie Canal, the Delaware Raritan Canal, the Cape Cod Canal, the Mississippi & Warrior Waterways, and any other inland waterways which may be taken under the control of the Railroad Administration in the future. Mr. Tomlinson at the present time is Federal manager of New York and New Jersey canals under the Railroad Administration, and also had been a member of the Inland Waterways Committee. The position of Federal manager of New York and New Jersey canals previously held by him will be filled in the near future.

## The Well Drilling Method of Blasting at Quarries

The usual method of blasting at large quarries at the present time is the well drill method. An interesting description of this system appears in a recent issue of the Du Pont Magazine, from which the matter following is abstracted.

By means of this well drill adapted to this purpose, holes are drilled in the rock the entire depth of the face of the quarry. They are usually 15 to 30 ft. back from the face, this distance being known as the burden, and are spaced about 15 to 20 ft. apart, 5⅝ in. in diameter being the most usual size. Any number of these holes can be fired by appropriate means at one time, but usually not more than 40 or 50 are attempted. By adapting the explosives used to the nature of the rock, it is possible to break it up in the size desired, and when properly spaced with the right burden, the broken rock is thrown out on the quarry floor without being scattered too far or without doing damage to buildings or other equipment unless some unseen weakness exists in the rock which cannot be guarded against. This is the most economical method of blasting rock for crushing at the present time, but requires a rather large and expensive equipment to handle it successfully. Although it is occasionally loaded by hand into the cars to go direct to the crusher, the more efficient way is by means of the steam shovel, by means of which broken stone is loaded into a train of cars, which are taken to the crusher by a locomotive.

Buffer Shot: Broken stone left in place to prevent fragments flying from the next blast.

One of the advantages of the well-drill system of blasting is that it admits of what is known as the "buffer" system of shooting. The illustration shows an example of this. It consists of throwing out a mass of broken rock in such a way that subsequent blasts can be fired before it is removed; that is, piling the debris up against the mass which has already been thrown out. In this way the rock from the first and second shots lies between the face and the steam shovel, so that the operation of the steam shovel is not suspended at any time. When this method is used, the steam shovel, and the cars which it fills, run on tracks parallel to the quarry face which is being blasted. The rock from each blast is simply piled up on top of and against previous blasts and is not thrown out on the quarry or on the tracks and equipment, so that the drilling and blasting can go on almost continuously and the tracks and equipment are never disturbed.

The limit in depth for well drills is from about 30 to 130 ft. Holes shallower than 30 ft. are not economical by the well drill method and holes deeper than 130 ft. are not often drilled, on account of the numerous difficulties which such a deep hole would entail.

Where slips and seams are known to exist in the face of a quarry, it is possible to guard against accidents sometimes by reducing the load of explosives at the weak point; this can be done by breaking the charge, as it is called, which is simply loading sand or rock dust into the hole at the weak point.

Not all quarries lend themselves to the economic use of the well-drill method. While limestone quarries which have a fairly soft rock to drill can be handled in this way no matter what the angle of stratification, harder rocks, such as syenite, granite, diabase, cannot be successfully worked by this method unless the stratification is horizontal, or nearly so, as the bits are liable to jam in the crevices where the rock seams form an acute angle with the line of the bore hole.

## Motor Driven Cars Operated by One Man in Quarry Transportation

Motor driven dump cars, operated by one man from a central tower, are employed at the quarry of the Casarpis Stone Co., Kenneth, Ind., for delivering to the crusher 5,000 to 6,000 tons of rock per 10 hour day. The installation is described in a recent issue of the Electric Railway Journal, from which the matter following is abstracted.

The 20 dump cars are served by three steam shovels. The cars receive their motive and control energy from a third rail system, at a central control tower. Except for their motor drive and the modifications in design required to permit the mounting of the motors, there is nothing of special interest in the construction of the dump cars themselves. The third-rail contact system was employed as being best able to meet the requirements relative to track shifting and extension. It is divided into sections, long or short, as the operating conditions may require. Independent feeders connect the sections with the central tower. In this tower is located the controller, by means of which one man can control the operation of all the cars in the system.

The motor controllers are located in banks at the right and left, while in the center is a bank of distributing switches, one switch being provided for each feeder. This arrangement makes possible the control of the cars on all track sections with a minimum number of motor controllers. These controllers do not make the main circuits directly but, by means of an auxiliary circuit, actuate electro-magnetic contractors as in some of the familiar types of electric railway controllers. The motor controllers have three main positions; forward, central or off, and backward. When a lever is pushed forward the rail section, which it is then controlling, is connected through its feeder and a resistor located at the tower to the 250-volt supply. As the lever is pushed farther forward the resistance is cut out. With the lever in the back position the same track section may be energized with from 30 to 100 volts for braking and control purposes.

# Seven Months of Government Operation of Railroads

In a report made to President Wilson on Sept. 9 Director General McAdoo reviews the work of the U. S. Railroad Administration during the first 7 months of its existence. Extracts from the report follow:

**Mileage and Capitalization American Transportation System.**—On Dec. 31, 1916, the total steam railway mileage in operation in the United States (all tracks) was 397,014 miles. This mileage was owned or controlled by 2,905 companies, employing some 1,700,814 persons. They had outstanding $10,875,206,565 of bonds and $8,755,403,517 of stock (par value).

The inland waterways system includes some 57 canals, 3,057 miles in length, some of which were owned or controlled by the railroads, and many thousand miles of navigable rivers, lakes, bays, sounds, inlets, traversed by innumerable craft. This briefly describes the plexus of transportation facilities which came under Federal control Jan. 1, 1918, or shortly thereafter.

**Condition of Railroads When Taken Over.**—When the Government took control on Jan. 1, 1918, the railroads were in a deplorable condition. Added to an unusually severe winter, the motive power was seriously crippled, and on the eastern lines traffic was badly blockaded by the congestion of unloaded cars at the terminals and elsewhere. The approximate number of loaded cars above normal, on the eastern lines, was 180,000 when the Director General took charge of the railroads. To relieve this situation was the first concern, and the energies of the Federal organization were exclusively and successfully directed to this end. At the date of this report there are no accumulations of loaded cars on the eastern lines above the normal.

**Economies Effected by Reorganization of Official Staff.**—The reorganization of the operating force has been made without any impairment of efficiency and with a reduction in the number of officers required and in the aggregate of the salaries paid them and chargeable to operating expenses. Under private control of the railroads 2,325 officers drawing salaries of $5,000 a year or over were employed, with aggregate salaries of $21,320,187. Under Government control 1,925 officials are doing the same work, and the aggregate of their salaries is $16,705,298—a saving of $4,614,889 per annum. This total includes the officers of the various regional districts as well as those of the central administration in Washington, except the Director General himself, who receives no salary. Regarding the salary question the report states:

> [illegible] sary that they should be justly remunerated, and that the re- [illegible] their life's work. It is not a question merely of operating the [illegible] ficiently attractive to draw constantly to it men of the right [illegible] cruited with such men it will be impossible to maintain the efficient organizations which are essential to the successful management and operation of the railroads of the country.

[illegible]

**The Consolidation of Terminals.**—Other reforms that are being worked out in the passenger service include the common use of the same terminals by railroads formerly in competition and using separate terminals. The most conspicuous example of the latter innovation is the use of the Pennsylvania Terminal in New York for through trains via the Baltimore & Ohio between Washington and New York. Plans for a similar reform in the service between other large cities which have a multiplicity of terminals are under consideration. The same principle is being applied as rapidly as possible in the consolidation of freight terminals. The saving of switching costs that will result and the greater rapidity with which cars can be loaded and unloaded is obvious.

**Shortening Freight Routes.**—Extensive studies have been made with the purpose of developing well-graded routes for the transportation of freight that will be shorter than those previously in use. Great progress has been made in this direction, especially in the West, and many new through lines are being developed. As one example of the economy that has thus been made possible it may be mentioned that recently during a period of about 60 days some 8,999 cars were rerouted in a certain western territory so as to effect a saving in the mileage traveled by each car of 195 miles, equal to a total of 1,754,805 car miles.

**Store Door Delivery and Intensified Use of Freight Cars.**—On Jan. 1, 1917, the railways of the United States owned about 2,400,000 freight cars. Delay in loading and unloading these cars and their use by both shippers and consignees as warehouses have very seriously diminished the carrying capacity of the roads.

As prompt unloading of cars upon their arrival at public terminals presupposes that congestion at the terminals shall be avoided, what is known as the "store door" system of freight delivery has been introduced in Philadelphia and New York and will probably be extended to other large cities. In Philadelphia, through the cooperation between the carriers, the commercial bodies, and the truckmen, it was established on May 1 and has proved itself effective in clearing the stations for inbound package freight 24 hours earlier than usual. It has recently been inaugurated in New York, where the usual notice to consignees to come and get their freight is no longer given. In lieu thereof immediate delivery of the goods is made by drays, thus doing away with free time at terminals. A reasonable charge for this service is to be paid by the consignees to the drayage companies employed.

If the plan shall vindicate the claims of its authors the congestion of inbound freight, which has hitherto prevented the prompt unloading of cars, will be a thing of the past, and it is suggested that ultimately it may be possible to collect outgoing freight by the same trucks which deliver to stores and factories incoming freight hauled from the terminals.

**Standardization of Freight Cars and Locomotives.**—It is said that 2,023 different styles of freight cars and almost as many different descriptions of locomotives were included in the equipment of American railroads prior to the war. The facts are not known, but nearly every important railroad had its own specifications for cars and engines. None of these was identical, and they were generally changed in some detail when new orders were placed. In a general way the same thing was true of the locomotives in use. Complete standardization will of course be impossible until the rolling stock and engines now in use shall have been entirely replaced by standardized types. Progress has, however, been made. Some 12 standard types for freight cars have thus far been agreed upon, and it has also been decided that hereafter only six types of locomotives of two weights each shall be purchased. The parts of these various types of locomotives and freight cars will be interchangeable. Their construction will be uniform and when repairs are needed they can be made with the greatest possible promptitude.

One hundred thousand freight cars of the agreed upon types have been ordered, and it is expected that the manufacturers can commence delivering them early in September. One thousand four hundred and thirty locomotives of the new type have also been ordered, in addition to about 2,100 that had been contracted for by the railroads prior to Jan. 1, 1918. Of the total of about 3,600 locomotives, some 1,185 had been delivered up to Aug. 1. The equipment of all the railways Dec. 31, 1917, included about 2,400,000 freight cars and 64,750 engines. The ratio which the newly ordered cars and engines bear to the total is not as large as is to be desired, and other orders will be placed as rapidly as the manufacturers can accept them.

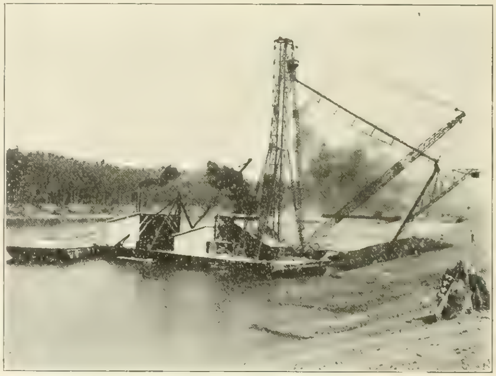
**Capital Expenditures for Improvements and Betterments.**—On Feb. 2, 1918, all lines under Federal control were directed to prepare and send in budgets of improvements immediately required to increase capacity and efficiency and to promote safety in operations. The budgets submitted in response to this called for expenditures chargeable to capital account—that is, exclusive of largs sums chargeable to maintenace —amounting in the aggregate to $1,328,493,609, which, upon careful revision by the Director of the Division of Capital Expenditures, was reduced to $975,105,416. This amount has been increased from time to time by new and unforeseen requirements, and particularly by large orders for freight cars, until the improvements definitely authorized to this date amount to $1,151,967,240. Of this amount, $441,604,460 is for additions and betterments, $666,824,180 for equipment, and $43,538,600 for construction of extensions, branches, and other lines.

Appropriations have been directed to work necessary to facilitate indispensable transportation, rather than those improvements which, while desirable and even necessary, are yet more for convenience and economy than for capacity and efficiency in the actual movement of traffic. This is indicated by the very large appropriations for equipment—almost wholly for engines and freight cars; and of the additions and betterments, much the largest item was for additional yards, sidings, etc.; next, shop buildings, engine houses, and appurtenances; and, third, additional main tracks.

**Revenue Ton Miles.**—The number of tons of revenue freight carried 1 mile, commonly known as revenue ton-miles is the ultimate measure of service in railroading. Applying this measure we find that the revenue ton-miles of 94 per cent of class 1 railroads (i.e., those having an operating income in excess of $1,000,000 per annum was 34,250,247,814 miles in April, 1918, as against 31,464,837,365 miles in the same month in 1917. The increase is equal to 8.9 per cent. The average number of freight cars in service had increased by 5.1 per cent, being 2,387,670 in April, 1918, as compared with 2,271,359 in 1917. The number of tons hauled per train shows an increase of 6.9 per cent, being 696 tons in April, 1918, as against 651 tons in April, 1917. The percentage of increase in the carload is even greater, being 14.4 per cent, the average carload in April, 1918, being 29.4 tons as against 25.7 tons in April, 1917. The revenue ton-miles for freight locomotives shows an increase of 7.9 per cent, being 1,125,875 in April, 1918, as against 1,045,921 in April, 1917.

## Portable Gravity Plant for Constructing Concrete Paving on River Banks

Excellent results in the construction of revetment on the banks of the Mississippi River have been obtained by the U. S. Engineers Office, Vicksburg, Miss., with the portable gravity concreting outfit shown in the illustration. This plant is stated to have placed 182 squares of concrete pavement on its first day of optration. The best previous record for work of this kind on the Mississippi River was 105 squares. The steel tower is 104 ft. high and the steel boom is 80 ft. long. The roller hoist bucket has a capacity of 34 cu. ft. and the hopper a capacity of 54 cu. ft. The special boom chute has a length of 80 ft. and the counterweight chute is 50 ft. long. The outfit is carried on a 38x120 ft. barge. The gravity plant was made by the Insley Mfg. Co., Indianapolis, Ind.



Portable Gravity Plant Equipment Employed by U. S. Engineers Office, Vicksburg, Miss., for Mississippi River Revetment Work.

**60-Ft. Fill Made from One Trestle.**—In connection with the double tracking of the Pennsylvania R. R. between Kensington and Summerville, O., a 60-ft. fill is being constructed from a single trestle. The contractors, the H. E. Culbertson Co., Cleveland, estimated that a 60-ft. trestle would be more economical than to make the fill in sections with lower trestles. The benches are 15 ft. apart and are made of pole timber. They have to be pushed back to a certain extent to prevent them from pushing out, but on the whole, the method is stated to be proving successful.

**Contractors May Organize National Association Sept. 23.**—A meeting of the committee of contractors, appointed some weeks ago to perfect plans for a National Association of General Contractors will be held Sept. 23 at New York City. It is expected that definite steps will be taken at that time for the formation of the association. D. A. Gerber of the Northeastern Construction Co., 225 Fifth Ave., New York City, is chairman of the committee.

# Chamber Blasting Methods and Costs

An excellent article on blasting for steam shovel work in mining operations appeared in a recent issue of the Mining and Scientific Press. The author, Mr. E. E. Baker, describes the method employed at the mines at Chuquicamata, Chili. Inasmuch as these methods are applicable to conditions in the United States the article in greater part is reprinted below.

**Reasons for Changing from Churn Drilling to Tunnelling.**—In blasting for steam-shovel work at Chuquicamata, Chili, where the height of the bench now being operated is about 180 ft., there were many problems to be solved before satisfactory work was accomplished. In consequence of the high cost of drilling with churn-drills, namely, \$3.60 per foot, some other means of blasting had to be found. The excessive cost was due to the hardness of the rock, and to the many seams and fractures throughout the deposit, causing excessive breakage of tools. Also the high cost of coal (\$23 per ton) was an important consideration. The comparison of drilling records on this material with those from drilling in such porphyries as the Nevada Consolidated orebody shows an average footing per 9-hour shift at Chuquicamata of 8 to 12 ft. as against an average in Nevada of 60 ft. This large difference, together with the increased cost of supplies in South America, readily shows that churn-drill costs in the soft-porphyry mines cannot be equaled in the harder granite at Chuquicamata. This work at the Nevada Consolidated in normal times costs a maximum of 50 ct. per foot.

The higher the banks became, starting from the contour and finally reaching 180 ft., the more footage was necessary; so that, say in a 150-ft. bank, one had to balance a drill-hole of 150 ft., together with the expense of springing a pocket for the blasting charge, against the cost of running a mine-drift 25 ft., which was the spacing between the drill-holes. Blasting by churn-drills, even to a height of 60 ft., in this material, cost as high as 25 ct. per ton, so that it became evident early in the blasting operations that some other method must be devised. The result was that the blasting methods were changed from churn-drill holes to underground tunnels. It is surprising to find how little is written on the subject; accordingly the work in blasting by tunnels was experimental from the start. [Gillette's Handbook of Rock Excavation describes many chamber blasts.—Editors.]

**Location of Blasting Tunnels.**—The floor of the blasting-tunnels was placed three meters below the floor of the steam-shovel grade, and the horizontal depth into the bank was made 15 m. In deciding on the depth below grade, one had to be certain that the blasting-charges were low enough so as to leave no hard bottom for the steam-shovels. In the many blasts that followed, 3 m. (9.8 ft.) was found to be satisfactory, and where the height of the bank was 45 m. (147.6 ft.) the horizontal distance was increased to 30 m. It was found that the horizontal distance could be two-thirds of the height of the bank to be blasted, so that the spacing of the drifts became 15 m., 22½ m., or 30 m., depending upon the height of the bank. By exhaustive experiments it was ascertained that the best form of wiring was in multiple-series, that is to say, five strings of caps each, and these connected in multiple to the main blasting leads. In each case all charges were double-primed, each cap of the blasting-charge being connected to an independent series of wiring back to an independent transformer, both controlled by the one switch on the higher voltage-line, which in this case carried a current of 500 volts, so that in case of failure of any part of one series of connections, the blaster was protected by having the second series to depend upon. From the figures that follow, when it is realized that a blast of this kind may cost upward of \$50,000 for its preparation before the blasting-switch is thrown, it is seen that great care must be exercised to insure success.

**Detonation of Blasting Charges.**—The detonation of these charges, the best spacing of which was found to be 10 m. center to center, was accomplished by the use of 60 per cent nitro-glycerine dynamite; the proportions of dynamite used being 2 per cent of the weight of the blasting-charge. The detonators consisted of two or three boxes of dynamite per charge, the top of one of which had been previously removed, a hole bored in each side of the case, and two sticks primed with a No. 6 electric exploder. The fuse-wires were placed through the hole of the box on each side, each cap being connected to its separate system of wiring. This case of dynamite, with others alongside, if necessary, was placed in the heart of the black-powder charge, which was loaded in the containers, cans, or sacks, as the case might be, without any attempt being made to open them. Each set of leading-wires was placed in grooved 2 by 3-in. lumber, and battened down with half-inch battens over the top of the groove. These conduits were placed on either side of the bottom of the drift, the fuse-wires of each detonator being connected in series to its system of wiring.

**Connecting Cross-Cuts Bulkheaded with Run of Mine Tamping.**—The first blast fired was bulkheaded in the connecting cross-cut to the next in the rear by a 10-ft. block of concrete. After the shot, the concrete was so undisturbed that this procedure was found unnecessary, and the cross-cuts were subsequently filled with run-of-mine rock only. Since the gases formed by an explosion of black powder are said to be about 300 times the original volume at 60° F., and since the increase in volume for each 5° rise in temperature is 1 per cent, it is estimated, from the fact fused feldspars were found in the vicinity of the blast, that the temperature of the explosion is at least close to 2,000° F. This would give a volume of gas 1,164 times the volume occupied by the original charge, so that the refinements in loading with a charge of this size, in taking pains to fill all interstices and voids, is altogether unnecessary. The loss in explosive force would be at the most but a small fraction of 1 per cent. Since the gas is formed almost instantly, there is no time for this volume to get through the cross-cut tamped with mine rock, and the breaking of the bank follows.

**Loading of Drifts.**—Although there is danger attached to all forms of blasting, when powder is handled without opening the containers, when electric safety-lamps are used, and strict regulations are enforced as to smoking and carrying matches, the danger of the operation is greatly minimized. Doors were placed in the cross-cuts at the entrance to the drifts to be loaded, with only the blaster and his crews having access to this compartment. The loading of the drifts was done at night, as there were fewer men on that shift working in the mine, and also fewer on the steam-shovel bench. As far as possible, it was aimed not to have steam-shovels working in front of the sections which were being loaded. It was found that mining operations could be carried on in the drifts next to those being loaded, so that this work need not be retarded during the time of loading. Blasting by tunnels is, of course, not new, but the usual way was by an adit with drifts. This was impracticable with steam-shovel work, because each time a shovel would pass the entrance to the tunnels would be lost, so that it became necessary to sink shafts some distance back from the working-face, and to drive the blasting-drifts from a cross-cut extended from the bottom of these shafts.

**Cost of Blasting.**—The largest blast at Chuquicamata was fired in three sections, the first on Nov. 19, 1916; the second on Nov. 21, and the third five days later. These sections could have been fired simultaneously, except for the steam-shovel equipment, which had to be changed from one section to the other, so that ore-loading operations could be carried on without interruption, as the firing of the three sections would have tied up the greater part of the face. Section No. 1 consisted of 29 drill-holes in shallow ground, and 267.3 ft. of drift. Section No. 2 consisted of 29 churn-drill holes and 724 ft. of drift; in this case two parallel drifts being fired simultaneously. Section No. 3 consisted of 1,318.6 ft. of drifts, showing a section in which 30 m. in horizontal distance was blasted for the first time. The grand total of explosives consisted of 813,000 lb. of black powder, and 85,850 lb. of dynamite, or 450 tons, which broke 1,229,716 tons of ore at a cost of 10.59c per ton. The cost of the blast by section follows:

### SECTION I—TUNNELS AND BLAST-HOLES SEPARATED.

Tunnel K 3659—Blasted 11/19/16—7 charges.

| | |
|---|---|
| Ground broken, 49,840 m. = 65,188 cu. yd. = 140,644 short tons. | |
| Drifts and cross-cuts, 81.5 m. = 267.3 ft. at $13 | $ 3,474.90 |
| Filling, 50.9 m. at P13 Chilean pesos = P661.70 at $4.50 | 147.00 |
| Explosives: | |
| Black powder, 125,000 lb. at $0.0608 | 7,600.00 |
| 60 per cent dynamite, 2,500 lb. at $0.302 | 7.55 |
| Lead wire, 1,100 ft. at $4.25 per 500 ft. | 9.35 |
| Exploders, 14 at $4.54 per 100 | .64 |
| Casing for wiring 600 linear ft., 500 board ft. at $72 and labor, etc. | 40.00 |
| Transportation (burros), 8 days at $10.53 | 84.24 |
| Labor: | |
| Loading gang, 5 days at P104 Chilean pesos = P520, at $4.50 | 115.50 |
| Hoist-man gang, 2 days at P9 Chilean pesos = P18, at $4.50 | 4.00 |
| | $12,230.63 |

8.7 ct. per ton.

### CHURN-DRILL HOLES, SOUTH END—11/19/16.

| | |
|---|---|
| Ground broken, 41,680 m. = 54,514 cu. yd. = 117,620 short tons. | |
| Holes shot, 29 ..... 1,944 ft. | |
| Holes lost, 11 ..... 735 ft. | |
| 2,679 ft. at $3.60 | $ 9,644.40 |
| Springing (4 springs): | |
| 60 per cent dynamite, 9,750 lb. at $0.302 | 2,944.50 |
| Spool conducting wire, 21,500 ft. at $0.0021 | 45.15 |
| Exploders, 160 at $4.54 per 100 | 7.26 |
| Labor (first and second springs, 20 in one-half day, third and fourth springs, 20 in 1 day), 6 days at P104 Chilean pesos | 139.00 |
| Blasting charges: | |
| 60 per cent dynamite, 46,975 lb. at $0.302 | 14,186.45 |
| Leading wire, No. 14, 7,800 ft. at $4.25 per 500 ft. | 66.30 |
| Exploders, 58 at $4.54 per 100 | 2.63 |
| Labor, 5 holes per day, 6 days, at P104 Chilean pesos | 139.00 |
| Transportation (burros), 4 days, at $10.53 | 42.12 |
| | $27,216.81 |

23.1 ct. per short ton.

### SECTION II—TUNNELS AND BLAST HOLES SEPARATED.

Tunnels A 3569-3584—Blasted 11/21/16—21 charges.

| | |
|---|---|
| Ground broken, 72,190 m. = 94,420 cu. yd. = 203,714 short tons. | |
| Drifts and cross-cuts, 220.7 m. = 724 ft. at $13 | $ 9,412.00 |
| Filling, 178.2 m., at P13 Chilean pesos = P2,316.60, at $4.50 | 515.00 |
| Explosives: | |
| Black powder, 165,900 lb. at $0.0608 | 10,086.70 |
| 60 per cent dynamite, 3,200 lb. at $0.302 | 966.40 |
| Leading wire, 3,000 ft. at $4.25 per 500 ft. | 25.50 |
| Exploders, 42 at $4.54 per 100 | 1.91 |
| Casing for wiring, 1,460 linear ft., 1,220 bd. ft. at $72 and labor, etc. | 90.00 |
| Transportation, 10 days at $10.53 | 105.30 |
| Labor: | |
| Loading gang, 15 days at P104 Chilean pesos = P1,560 at $4.50 | 347.00 |
| Hoist-man, 3 days at P9 Chilean pesos = P27 at $4.50 | 6.00 |
| | $21,555.81 |

10.6 ct. per ton.

### CHURN-DRILL HOLES, NORTH END—11/21/16.

| | |
|---|---|
| Ground broken, 26,900 m. = 35,184 cu. yd. = 75,912 short tons. | |
| Holes shot, 29 ..... 1,263 ft. | |
| Holes lost, 7 ..... 363 ft. | |
| 1,626 ft. at $3.60 | $ 5,853.60 |
| Springing (4 springs): | |
| 60 per cent dynamite, 4,240 lb. at $0.302 | 1,280.48 |
| Spool conducting wire, 13,000 ft. at $0.0021 | 27.30 |
| Exploders, 144 at $4.54 per 100 | 6.54 |
| Labor (first and second, 20 springs in one-half day, third and fourth, 20 springs in 1 day), 6 days at P104 Chilean pesos | 139.00 |
| Blasting charges: | |
| 60 per cent dynamite, 23,375 lb. at $0.302 | 7,059.25 |
| Leading wire, 5,100 ft., at $4.25 per 500 ft. | 43.35 |
| Exploders, 58 at $4.54 per 100 | 2.63 |
| Labor, 5 holes per day, 6 days at P104 Chilean pesos | 139.00 |
| Transportation, 3 days at $10.53 | 31.59 |
| | $14,582.74 |

19.2 ct. per short ton.

### SECTION III—TUNNELS ONLY.

Tunnels B 3629 T-T 3644 E—Blasted 11/26/16—36 charges.

| | |
|---|---|
| Ground broken, 320,655 cu. yd. = 691,826 short tons. | |
| Drifts and cross-cuts, 402 m. = 1,318.6 ft. at $13 | $17,141.80 |
| Tamping, 9,427 ft., 287.4 m. at P13 Chilean pesos | 830.26 |
| Explosives: | |
| Black powder, 522,100 lb. at $0.0608 | 31,743.68 |
| Dynamite, 60 per cent, 7,000 lb. at $0.302 | 2,114.00 |
| Dynamite, 62 per cent, 2,600 lb. at $0.6007 | 1,561.82 |
| Dynamite, 75 per cent, 200 lb. at $0.30 | 60.00 |
| Leading wire, 5,500 ft. at $4.25 per 500 ft. | 46.75 |
| Exploders, 72 at $4.54 per 100 | 3.77 |
| Casing for wiring, 2 lines, 2,210 bd. ft., plus labor | 163.92 |
| Transportation, 30 days, at $10.53 | 315.90 |
| Labor (loading gang), 25 days at P105 Chilean pesos; hoist man, 18 days at P9 Chilean pesos | 613.78 |
| | $54,595.68 |

7.9 ct. per short ton.

### RESUME OF ALL THREE SECTIONS.

| Tunnels blasted November, 1916. | Short tons broken. | Cost per short ton, cents. |
|---|---|---|
| K 3659 | 140,644 | 8.7 |
| B 3622 T-T 3644 E | 691,826 | 7.9 |
| A 3569-A 3584 | 203,714 | 10.6 |
| Total | 1,036,184 | 8.53 |
| Churn-drill holes, November, 1916. | | |
| At south end of bench | 117,620 | 23.1 |
| At north end of bench | 75,912 | 19.2 |
| Total | 193,532 | 21.6 |
| Tunnels and blast-holes. | | |
| Tunnels | 1,036,184 | 8.53 |
| Blast-holes | 193,532 | 21.6 |
| Total | 1,229,716 | 10.59 |

### UNIT COSTS.

| Costs: | U. S. currency. |
|---|---|
| Driving, per ft. | $13.00 |
| Tamping, per metre | ...... |
| Black powder, per lb. | 0.0608 |
| Dynamite, 60 per cent, per lb. | 0.302 |
| Dynamite, 62 per cent, per lb. (purchased locally) | 0.6007 |
| Dynamite, 75 per cent, per lb. | 0.30 |
| Leading wire, per 500 ft. | 4.25 |
| Conducting wire, 450 ft., 2-lb. spool | 0.946 |
| Exploders, per 100 | 4.54 |
| Casing for wiring, per 1,000 board ft. | 72.00 |
| Labor: | |
| Loading gang (9 men), per day | ..... |
| Hoist man, per day | ..... |
| Transportation: | |
| 10 cargo burros, per day | 4.00 |
| 3 burros for men, per day | 1.20 |
| 1 capataz | ..... |
| 2 burreros | ..... |
| 9 trips of 2,000 lb. per day. | |
| Total for transportation, per day | 10.53 |
| Blast-hole drilling, per ft. | 3.60 |

Casing for wiring, 2 lines for total length of drifts and cross-cuts.
Leading wire, 4 lines for total length of drifts and cross-cuts.
Exploders, 2 for each tunnel charge.
Exploders, 2 for each blast hole.
Springing (4 times)—first and second, 20 springs in one-half day; third and fourth, 20 springs in 1 day.
Loading blast holes, 5 holes per day with dynamite.

The marked difference in the cost by tunnels, 8.53 ct. and the cost by churn-drill holes, 21.6 ct., was forcibly shown by the results of these blasts and proved conclusively that the tunnel method was doing the work for less than half the cost of the same work by drill-holes. The above costs do not include the expense of block-holing the boulders, following the large blasts; this is taken up later. Neither is allowance made for the proportion of overhead expense.

**High Bank vs. Low Bank Method.**—Much controversy has arisen over the so-called method of high banks versus the method of low banks as applied to the work at Chuquicamata, the arguments being that the smaller the height of the bank, the smaller will the rock be broken, the safer the operation, and the more efficient the shovel-performance. On the other hand, with drill-holes, one is apt to have trouble with pockets, leaving hard rock in the bottom for the shovel to handle, missed holes are more likely to occur; and any delay to the churn-drill operation, resulting from lost holes, broken tools, and so on, would mean stoppage in steam-shovel loading, all of which would be reflected in the costs against the low-bank method. The question resolves itself into that of the cost per ton placed in the bins, and I do not believe that any increase in shovel efficiency in the low banks, owing to a lower amount of large rock, will offset the large difference in cost by breaking the ground by the tunnel-method over that of the blast-hole method. While it is admitted that there will not be the same proporion of large rock in the low banks as in a higher bank, it must not be forgotten that in certain sections, both at Chuquicamata and at Ajo, rock too large to be handled resulted from blast-hole drilling where the banks did not exceed 50 ft., so that low banks do not entirely eliminate this objection.

Churn-drills were used exclusively at Chuquicamata until the heights of the banks reached about 60 ft., and coarse rock was produced continuously, which, together with the resulting hard bottoms, missed holes, and excessively high cost, resulted in this method being superseded by tunnel-blasting, the difference in cost being demonstrated above. In the case of the blast-holes fired in section 1, should there have been no lost holes, and should the net footage, namely, 1,944 ft., have cost but $1 per foot instead of $3.60, we would have substituted $1,944 for the $9,644, and the total cost of the drill-hole factor in this shot would be $19,516.81, or 16.6 ct. per ton, so that even with the high cost of drilling eliminated, the cost per ton broken would still be approximately twice that for breaking the ground in the same vicinity by tunnels. During the 3 years of blasting by the tunnel-method in this way at Chuquicamata, there never has been a miss-fire, although in the churn-drill blasting there have been several. Missed holes from churn-drill practice are largely accountable to the tamping scouring the leading or connecting wires, so that short circuits develop and the cap in one hole does not explode, while all the rest are detonated successfully. In blasting a string of holes one missed hole is usually hard to locate, and it is not until the shovel is digging in this section that the unexploded charge is found, and in nine cases out of 10, the teeth of the dipper will be into the charge before the powder is discovered, so that the chance for accidents from this source is great. In blasting by the tunnel-method, the blaster's wiring connections, caps, and the like, are all within his reach, and can be inspected carefully, whereas in the drill-hole no one knows what has taken place; it must be taken for granted that the connections in the bottom of the hole are all right. A galvanometer test will show the hole to be safe, when really the wires are perhaps "shorted" across the cap. With regard to the height of bank best suited to the purpose of selecting ore, I would be inclined to say that the lowest bank consistent with good steam-shovel practice would be the most desirable. It has been found, however, in high banks, that where zones of waste appear, they tend to slide into the shovel-pit, so that fair sorting can be accomplished; that is, if the bottom of the bank is ore and the top is waste, the shovel will load ore at the bottom until the top caves, after which waste will be loaded, so that there is little to be said in favor of any given bank-height for this purpose. The irregularity of ore and waste is such that no matter how shallow the bank may be, there would be times when ore and waste would be mixed.

With regard to the large rock found in blasting hard-rock sections, the experience at Chuquicamata was that no matter how these hard sections were shot, the big rock could not be broken in the blasting. Tunnels have been overloaded as much as 100 per cent, and underloaded so as merely to shake the bank, and the results, so far as big rock were concerned, were practically the same. This is true also in the good blasting ground, as the steam-shovel operator understands it; that is, ground that will break fine with low banks in churn-drill blasting also will break fine on a 150-ft. bank with tunnel-blasting. In the last shovel-cut, where the machine is close to the bank, care must be used to have rocks endangering the machine barred down. For this reason it was decided not to clean up the blasts entirely, which meant the re-shooting of a small amount of ground already blasted. In the end this was more desirable than to clean up the face, thereby endangering the operating equipment.

**Undershooting of Hard Blocky Sections.**—There were times when hard block sections were undershot. This is a costly mistake, as a hard section of bank, which is only shaken, has to be fought with block-holing and jack-hammer work; this is tedious and costly. For that reason it invariably pays to be sure that enough powder is used to break the ground, and, for a safety factor, to overload from 20 to 30 per cent in addition. On the other hand, too much of an overload scatters the bank, so that track shifting becomes excessive, and the resulting low banks of broken material call for much moving, and give a low steam-shovel efficiency. Successful blasting under any given set of conditions, requires experience; for example, a given quantity of powder that will break a certain tonnage in one case may over or undershoot the same quantity in other conditions. The softer the rock usually the greater the blasting-charge necessary, as soft material tends to spring, while the harder rock will break with the same charge.

**Blasting Powders.**—Much has also been written of the merits of different blasting-powders, many claiming that dynamite will fracture the rock finer. In blasting on a large scale this is not so. Were enough dynamite used to shatter the rock, the bank would be blown all over the steam-shovel bench. Dynamite, of course, does shatter more than black powder, on account of its rapidity, but only close to the blasting-charge. In calculating the charge to properly break a bank, practically the same conditions result, whether dynamite or black powder is used. Black powder for Chuquicamata was made at Calama, a town 15 miles distant. The ingredients used were, roughly, 75 per cent sodium nitrate, 15 per cent charcoal, and 10 per cent sulphur. Extreme care was not used in this mixture, nor were the ingredients analyzed, but the powder was grained and glazed, and was most satisfactory. It cost, delivered at the mine, about 6 ct. per pound, and a given amount of 40 per cent dynamite was equal in blasting strength to about $1\frac{1}{2}$ times the weight of the powder of local manufacture. Black powder was, all things considered, by far the most satisfactory, although many varieties and grades of explosives were tried. The commercial $NaNO_3$ used in this powder was as a rule rich in $KClO_3$. Higher-grade dynamites were used as a rule in drill-hole blasting, in order to get the most out of the pockets formed by springing, as previously stated.

**Blasting Charges.**—As wide a range as from 400 to 1,200 lb. of black powder was used per linear meter of line of least resistance. It was early demonstrated that the height of the bank was of little importance in calculating a blasting-charge; that is, if the line of shear was 50 ft., the blasting-charge would be approximately the same, whether the bank was 100 ft. high, or of indefinite height. A drift through a section of "hog-back," with the same line of shear throughout, and with heights of 40 ft. at each side of the ridge, and 130 ft. in the center, was loaded on a basis of cubic yards to be broken, in order to prove this principle. The result was that the center of the blast, or the point under the high part of the ridge, was greatly overloaded, while the section of low-bank heights was properly broken. The resulting pile of broken rock formed a semi-circle, with a point under the highest part of the ridge taken as a center. It was clear from this point that it was necessary to calculate on the line of least resistance only, and this practice was thereafter followed.

Owing to the variable conditions in the rock to be broken, no empirical formula could be devised, and it was only from blasting in certain sections that knowledge was gained as to what factors per meter of least resistance should be used. The cost of driving the drifts, 4½ by 6½ ft. in section, at Chuquicamata, varied from $10 to $20 gold per foot, with an average of $13. The ground being hard and dry, no timbering was required. Muck was trammed from the faces in buckets on trucks, and during the operation of loading, the space between the blasting-charges was filled with run-of-mine by this equipment. The greater spacing of the drifts required a larger blasting-charge, which filled from 70 to 90 per cent of the tunnel. No chambers were required to accommodate the blasting charge as the charges were loaded in the drifts themselves. The greater the space between the drifts, of course, the less cost per ton broken. In the beginning, it was useful to have the drifts spaced 15 m. only, so that, in case the blast were undershot, the drift immediately behind could be reloaded, this time with an overload and the material of both blasts knocked down successfully. This did not happen often, but it is well for the blaster to know his ground before adopting the maximum spacing. The factors per line of least resistance, on a 30-meter spacing, show an increase per meter over the factors for a 15-meter line of least resistance in the same ground. The loading of drill-holes on the basis of a given factor per foot in depth of hole, with the slope as a constant ratio, always gave good results, as the line of least resistance is proportionate to this height. Where the horizontal distance is uniformly two-thirds the vertical height, the factor per cubic meter works out well, and varies in this material from 1½ to 2½ lb. per cubic meter to be broken.

**Precautions Taken After Blast.**—After a blast by the tunnel-method, and before the miners are allowed to return to work in the blasting-tunnels that are in preparation, the helmet-crew, consisting of three men, one or more supplied with a bird in a cage, descend into the mines, and test all the drifts for bad air. The helmet-crew usually does not enter until 24 hours after the blast, and it is seldom found that gases entering the mine interfere with the work for a longer period than 48 hours. It is always well to maintain a regular helmet-crew to do nothing but act as a life-saving squad. They should have regular exercises and duties to perform daily, in connection with their work, and be always available at a moment's notice, because, in the case of a premature explosion, the great danger to the men underground would be from asphyxiation.

**Springing Holes.**—The springing of churn-drill holes is at best a most unsatisfactory procedure, as one is never certain that the pocket sprung is going to be large enough to accommodate the blasting-charge. If not large enough the powder will rise in the barrel of the hole. In the case of blasting at Chuquicamata, it was most essential to have a pocket of ample size, because, when the bottom could be successfully blasted, the top would take care of itself. In springing with 75 per cent nitro-gelatin, which is the best explosive found for this work, from 12 to 15 per cent of the weight of the full blasting-charge as a rule was used to spring the pocket. So much has been written about springing holes that I need make no comment here other than to say that the quantities used in springing holes usually increase in multiples of three, when the chamber is springing as it should. Where the collars of the drill-holes are likely to blow out, and where the ground is soft, and manifests a tendency to cave, it is often best, where the blaster has plenty of time, to use sand instead of water, and to fill the hole each time. This is costly, as the drill has to be placed over the hole each time to clean out the sand from both the hole and the pocket. Where the springing of drill-holes is in good ground, and where water can be used successfully for tamping, the usual rule is to use a gallon of water per pound of springing-charge, the quantities to be varied afterward according to the results obtained. By the use of a mirror to reflect the sunlight to the bottom of the hole, and by means of the tamping-dolly, which consists of a piece of round wood 36 to 40 in. long, tied preferably to a piece of window-cord, the blaster soon learns, within reasonable limits, whether or not he will be able to "chamber" the charge in the pocket. When a hole gives trouble—and there are few that do not—the blaster tries to make up the difference in the blasting-powder necessary in the two adjacent holes. This invariably leaves a hard bottom for the shovel to work against, thereby seriously interfering with efficiency in loading. A pocket that proves to be too small is disconcerting, as, for example, when the blaster had calculated that 5,000 lb. of charge was required and then finds that the pocket is full after 1,000 lb. has been placed in the hole.

**Ore Deposits, Equipment at Mines and Chilean Labor.**—The entire outcrop of the deposit, which is about three kilometers long by half a kilometer wide, is honeycombed with old workings and small dumps, some dating no doubt from pre-Incarial times. These in some respects were an advantage, as the excavation for railroad construction through these dumps was cheap, but they interfered with the churn-drill operations, since the holes required casing in sinking through the dumps and the old workings. The dumps were excavated for about 25 ct. per cubic meter by native hand work, and the hardest rock was excavated for 80 ct. per cubic meter. There are now being operated at Chuquicamata, 8 or 10 steam-shovels, and about 15 locomotives, 1 electric shovel, 2 electric churn-drills, and about 12 steam churn-drills, all of which have been successfully manned by Chilean mechanics. The problem was difficult at the beginning, and required patience and encouraging words, and the training was accomplished in the face of much derogatory criticism. The achievements of the better class of Chilean mechanic, even to the drilling of 1,500 churn-drill holes with steel lines, goes to show that the men of the Southern Continent are well able to keep abreast of the times in the use of modern equipment. These Chilenos took particular pride in their work, and were very reliable; they were proud of their ability and realized the necessity of not missing a day, because the work of the machine depended on their punctuality. The Chilean laborer has an independent spirit, but at all times is subject to reason. He knows well enough when he is guilty of a breach, and he knows that the reprimand that he receives is justified. Much better results are accomplished by means of piece-work or on contract. In the operation of drilling-machines and steam-shovels, they were paid a bonus for work exceptionally well done. It is better to encourage and to lead the Chilean laborer than to attempt to drive him. It must be said also that I have never met with better workmen anywhere than the gangs of Chilean shovelers working on contract.

## Rapid Building of Timber Cofferdam

In the construction of the Government lock and dam at Troy, N. Y., it was necessary to finish the west one-half of the concrete dam during one working season. In order to expedite this work a special method was selected for the rapid building of the frame work of the 1,000 ft. long wooden cofferdam.

Launching Section of Cofferdam Framework

This frame work consisted of two horizontal and parallel sets of timber spaced about 20 ft. apart and tied across with iron rods and struts. The frame resembled two parallel board fences with a distance between the fence posts of about 21 ft. In building two corresponding sets of timbers were placed on a pair of cradles laid flat on a barge. The two cradles were then raised, the tie-rods were put in, and the timbers bolted to the portion just completed. The new section was then picked up by derrick boats and slid part way over the side of the barge until there was room enough to lay down another set of timbers on the cradles, which were again raised up when ready and connection made with the preceding section. Later these frames were lined with sheet spiles and the dam filled with sand and gravel. By this method it was found that the timber work could be built very rapidly, the greatest speed attained being 100 ft. in two 8-hour shifts.

## Method of Blasting Out Ice Gorge

Much trouble was caused last winter by ice gorges in the Monongahela River. One of these at Pool No. 5 of the Government lock and dam system could not be handled by towboats and accordingly was dynamited by the U. S. District Engineer. The methods employed were described by Lt.-Col. H. W. Stickle, U. S. Army, in a paper presented before the Engineers' Society of Western Pennsylvania.

The lower end of the gorge began at the Bridgeport tipple ice-breakers, 0.7 miles above Lock No. 5. The ice was packed to the river-bed except in the channel where it varied from 4 to 6 ft. in thickness. Farther up stream it was found to be of greater thickness and more compact until at the cofferdam, about 2,000 ft. above the Bridgeport tipple, it was packed about 6 ft. below the river surface and piled to a depth of 4 to 12 ft. above the river surface for a distance of 600 ft.

This ridge of ice extended diagonally across the river and was wedged between the cofferdam and the mouth of a small creek on the opposite side of the river a short distance below. This ridge formed the key to the situation since it was of sufficient strength to stop the ice, piling against it from above, and by its position it protected the field of less compact ice below it. To break this key it was attacked from the down-stream side after a channel 1,500 ft. long had been blasted through the ice-pack below.

After all shore ice possible had been loosened at the lower end of the gorge by ramming with steamers, blasting of the channel up-stream through the center of the ice-pack was started. Eight holes were first disposed in a semicircle of about 300 ft. in diameter, the curve being convex to the direction of the current. The holes were from 12 to 18 in. in diameter, chopped through the ice or to the river-bed where necessary, with a long chisel bar. From 10 to 12 lb. of 40 per cent dynamite per hole were tied in weighed cement sacks, lowered through the holes and suspended under the lower surface of the ice. All eight shots were exploded simultaneously.

The ice was well shattered in the areas encircled by the holes and for 10 to 20 ft. above each hole. After all loose ice had floated away, a steamer by ramming and then pulling with a snag hook, removed everything up to the solid breast. The same procedure was followed with successive series of holes until a channel 1,500 ft. long had been cut up-stream to the ridge forming the key. The number of holes was decreased from eight at the down-stream end of the channel to five at the up-stream end, the width correspondingly decreasing from 300 ft. to 100 ft. The width was also controlled to some extent by variation in loading of the end holes of each series. A line of five holes was then laid out diagonally, up-stream from the opened channel to the left shore opposite the mouth of the creek, and in such a position as to cut across the down-stream corner of the ice ridge. When these holes were fired, the greater part of the ice along the left bank below them was loosened and floated out and a slight movement of the ice ridge was noted. A second diagonal line of holes, paralleling the first line but about 300 ft. farther up-stream, was next fired, breaking the ridge at its juncture with the left shore. The entire ridge began to move, pivoting about its right end at the Brown cofferdam, and was quickly followed by movement of the entire gorge above that point, which at the time extended to Fredericktown, Pa. The river, at this time, was 7 ft. above the crest of Dam No. 5.

Moderating weather, together with softening and sinking of the ice, due to suspended silt, had started the upper end of the gorge to move and undoubtedly contributed to the success of the undertaking. In drilling blast holes it was noted that for the upper 18 in. the ice was very hard, but below that point it was usually softened and honeycombed and filled with silt. After the final movement had started, the entire gorge passed a given point in three hours, but it disappeared so rapidly, by shattering on the dams and sinking, that practically no ice reached Pittsburgh.

An attempt was made to use blasting-powder instead of dynamite to shatter the ice, but this proved to be a failure. Five 1-gal. jugs were each loaded with 10 lb. of blasting-powder and one No. 6 electric exploder. After the lead wires had been arranged in slits in the corks and sealed with soap, the jugs were suspended below the ice and the charge exploded. No appreciable shock or lifting effect was observed, probably because the action of the powder was so slow that pressure was relieved by displacement of the water.

## Digging Pole Holes With Dynamite

A method of setting a blast that will throw practically all of the earth out of a pole hole is described in the September issue of the Du Pont Magazine. The method consists of digging a hole about the depth of one cut of a long-bladed tiling spade and to the exact size of the hole wanted. The bottom is leveled off smooth, and the sides left perfectly straight. This much seems to be essential to good results. Then a hole is bored with a long 1½ in. auger until it is within a foot of the desired depth of the hole. This is to allow for the displacement of the earth downward from the charge. The hole must be made exactly in the center of the spaded hole. If the ground is gravelly or rocky, a punch bar or drill may be required. Then the charge is inserted and tamped down with earth and fired by blasting cap and fuse. A few experiments must be made before the required charge is ascertained, as the amount varies with different soils.

The principle on which this system depends is the slight difference in the resistance of the earth in the sides of the hole over that in the center from the greater thickness. This puts the mass of earth from the bottom of the spade hole down to the blast in the position of a charge of shot and wadding in a gun. When the blast is fired, this mass is started a little easier than the surrounding walls, if the spade hole has been dug deep enough. Then as it springs loose, the force of the blast concentrates on it and throws it out clear and clean. The force of the blast drives the hole at least a foot below the charge, and the hole is completed. This method is not recommended for sandy or light loam soils, as they crumble too badly under the force of the blast.

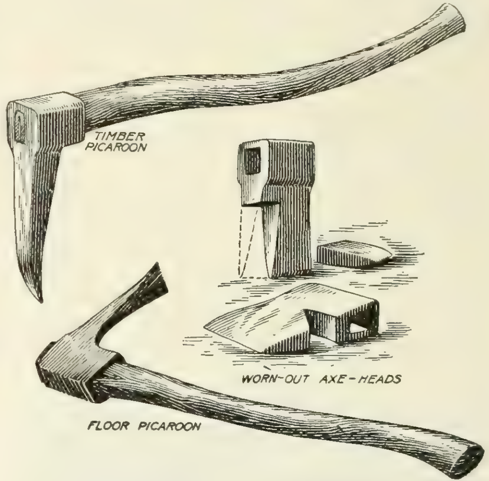
## Horse Push Scraper for Leveling Edge of Fill

A push scraper has been found an effective tool for leveling the edges of fills. As employed by a Chicago contractor the arrangement consists of a long piece of timber attached to the front wheels of a wagon. The rear end of the timber is counterweighed and the front end carries a plank scraper. The horses are hitched midway of the timber and are alternately backed up and driven ahead, pushing the dirt over the edge of the fill in the forward motion.

## Useful Type of Pick and Adze Made from Old Axes

Axes that have been ground down to such an extent that little steel remains in the bits and the cutting edge is gone can be made into useful tools known as picaroons and picaroon-adzes. These tools have been employed by mining men for several years. The following description of their use and how they are made is abstracted from the Engineering and Mining Journal.

The picaroon is a useful implement for handling timbers or raising floors. It has a crook, so that a good purchase can be obtained in raising a plank when the floor has become wedged tightly between timbers. Owing to its hooked point, a picaroon will stick better in a timber when dragging or pulling it than a pick will. It is a tool for a special purpose and is kept sharp. The picaroon also can be used as a hammer and is in reality nothing but a special type of light pole-pick.



Picaroon and Picaroon-Adze Made from Old Axes.

The manner of making the picaroon depends upon the amount of metal in the axe head as well as the use to which the tool is to be put after it is made. That used by timbermen in handling timbers in the stope is made light and with a shorter point, so as not to pull out of the timbers too easily. Picaroons intended mainly for lifting floors are made with longer points and are heavier than those used for handling timbers. No new steel is welded into the axe metal to make a new point, but, instead, the metal of the axe blade is drawn out in such a manner that the bit of the axe will form the lower part of the point. Consequently, the lower part of the picaroon blade is made up of steel and iron welded together in a laminated manner so that it forms, when tempered, a tough and lasting point. If there is too much metal in the axe, part of it is cut out on the anvil before the new tool is shaped, as shown by the sketch. If there is likely to be a shortage of metal in the blade, a small V is cut in the lower side of the axe, just below the eye, and the remaining metal is driven down and drawn out to form the point, so that the steel of the bit will be kept in the lead as much as possible.

A picaroon-adze can be made from an old axe head in a similar fashion, but care is taken in drawing out the metal to keep the steel of the bit well in the lead, and all the metal is preserved so as to give weight to the tool. When the metal has been drawn out to form a point 5 in. long, an adze bit about an inch and a half wide is shaped, tempered and ground. A picaroon-adze will be found handy in chopping out a timber that cannot be removed with an axe or wood chisel.

Both the timber picaroon and the picaroon-adze are fitted with an axe helve for a handle, because it is curved and can be gripped securely and easily. The floor picaroon is fitted with an old pick-handle, for this is stronger and will permit of much more prying without danger of breaking while raising floors.

At the Bunker Hill & Sullivan mine, old pick eyes, no longer heavy enough to make good picks, are used to make picaroons. One end of the pick is cut off about 2 in. from the eye, and the other is drawn out to form a light slightly hooked pick-point, which has the same general appearance as the point on the axe-picaroon just described.

## Application of Lubricant to Wire Rope

An important point in the lubrication of wire rope is the application of the lubricant. Various methods have been employed, but in adopting any one method or combination of methods, states **Lubrication**, the particular mode chosen must be dictated by the specific problem encountered. On inclined and horizontal ropes, where operating speeds permit, operators very often pour the lubricant on the rope, the excess being caught in a pail, which serves the double purpose of container and overflow vessel. It has been found excellent practice to paint the lubricant on with a brush, catching the surplus, as before, in a pail. Good results have been obtained by providing each rope with a trough through which the rope is compelled to pass by making it run under a wheel mounted on the trough. Another device consists of a barrel fitted with steam coils, to insure a proper heating of the product, and a valve and short piping arrangement for furnishing a continuous flow of the lubricant to the rope, suitable means being provided for wiping the cable and conserving the excess dressing. Engineers report good service obtained by pouring the dressing on the winding drums. Others report that they have obtained best results by providing each rope with a split box of some 25 lb. capacity into which compounds can be poured while hot and through which the rope passes in operation.

## Accidents in Connection with Scaffolds

Nearly 3,100 accidents in connection with scaffolds in building construction were reported to the Pennsylvania Department of Labor and Industry in 1917. Of these accidents 65 were fatal. Falls from structures during erection were responsible for 217 accidents, of which 14 were fatal; 367 persons (14 fatally), were injured by the collapse of scaffolds and staging; 2,122 persons (31 fatally), were injured by falling from scaffolds and staging; 385 persons were injured (9 fatally) by material falling from scaffolds and buildings under erection.

**Skip Stop System for All Street Railways.**—Street railway companies of the United States have been instructed by the Fuel Administration to put into effect the "skip stop" system on all lines by the end of September. State fuel administrators have been ordered to obtain the installation of the system by Sept. 15, if possible.

## Safe Construction of Scaffolds and Falsework*

By T. F. FOLTZ,

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Poor and inadequate scaffold construction may be traced largely to the desire on the part of builders to use old and poor lumber. Subcontractors generally fail to include sufficient money in their bid to cover this contingency, depending on using scaffolds erected by the general contractor. These scaffolds may have been satisfactory for their original purpose, but in same cases may not be adequate for the use of the subcontractor. Even though sufficient money has been included in the bid for the erection of proper scaffolds, there is a great incentive to skimp this portion of the work in order to increase the amount of "velvet." Too much dependence is usually placed on picking up sufficient lumber about the job to construct scaffolds. In this way not only will improper sizes be used, but the material may also be mostly inferior and defective.

The work of building the scaffold is too often delegated to unskilled persons because it is not a permanent structure and appearance is no object. Many accidents can be traced to this cause, and it is surprising that we do not have more of them. The contractor should delegate a thoroughly experienced man to be responsible for this work, and all building, changing, and removal of scaffolds should be done under his jurisdiction.

**Pole Scaffolds.**—The general construction of the pole scaffold, used mostly by bricklayers, is as follows: Poles or uprights about 4 in. square in cross section are erected about 7 ft. 6 in. apart on a line approximately 4 ft. 6 in. from the wall. Stringers $1\frac{1}{4}$ in. thick and from 8 to 12 in. wide, depending on the load they are to carry, are nailed on the poles in a position parallel to the ground. These are spaced vertically about 5 ft. apart and serve as the outer bearings for the putlogs. The inner ends of the latter, having a cross section of about 3 by 4 in. and a length of about 6 ft. rest in holes left in the brick wall.

The putlogs support the platform planks, and there should be a sufficient number of them so that there will be at least three under every plank. With 16-ft. planks, about 2 in. thick and 10 in. wide, the putlogs may be spaced the same as the uprights, namely, 7 ft. 6 in. apart. If thinner planks are used the putlogs should be placed closer together. The planks, with the above dimensions, will lay 5 wide in the space between the buildings and the uprights. Their ends will overlap each other 1 ft., and there should be a putlog under this point of overlapping to avoid the formation of a blind trap.

It will not be necessary to nail the putlogs or planks in position unless local conditions require that they be erected on an incline, or heavy vibration or other considerations should necessitate such a precaution. There should be a guard rail, at least 3 in. by $1\frac{1}{2}$ in. in cross section, erected along the uprights parallel with the platform and about 34 in. high. A similar guard rail should also extend across any window openings on the building side of the platform where these openings extend to more than 34 in. above the platform. Below this rail, along the outer edge of the platform, a toe board about 6 in. deep should be provided to prevent material from falling from the scaffold. If material such as bricks is to be placed on the platform in piles higher than the toe board, then the latter should be higher accordingly, or the space between the toe board and the guard rail should be filled in with boards or substantial wire screening.

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In order to eliminate the possibility of the pole scaffold collapsing in a direction parallel with the walls, there should be substantial diagonal braces nailed across the uprights. There should also be braces nailed to the building at various points, such as window frames and other points of attachment, in order to prevent the scaffold from falling away from the building. On blind walls where there are no points available for nailing braces of this kind, spring stays may be used. To make a spring stay, two boards are inserted in the hole in the wall left by the removal of a putlog in raising the platform to a higher level, and a brick is then placed between the two boards and pushed to within a few inches of the wall. The outer ends of the boards are then sprung together and nailed fast to the scaffold. The result is that both boards at their inner ends are pressing against the top and bottom of the hole with such force that there is sufficient holding power to prevent the scaffold from falling away from the building.

**Independent Pole Scaffolds.**—The design of the independent pole scaffold departs somewhat from that of the pole scaffold. Instead of using the building as the inner support for the platforms, an additional set of uprights is erected close to the building. This kind of scaffold is often used by stone masons as it is usually undesirable to leave openings in stone walls for the reception of putlogs. These scaffolds are usually made in larger dimensions than the pole scaffolds, and a greater amount of bracing is necessary on account of their being independent of the building for support. Instead of the usual putlogs resting upon the ledgers as in the pole scaffolds, boards about 1½ in. thick and about 9 in. wide are nailed on the sides of the uprights just above the ledgers and perpendicular to them and the building. These bearers, which correspond to the putlogs, add considerable bracing to the structure on account of being nailed fast.

This scaffold is usually made twice as wide as the pole scaffold, and larger members are used throughout on account of the greater strain upon the various parts. The method of laying flooring is substantially the same as that for the pole scaffold, and the same consideration should be given with reference to the guard rails and toe boards. Better footing is required in these scaffolds on account of a greater weight resting upon each upright. Where there is any question as to the ability of the soil to hold the pole, there should be a substantial block of wood, about 2 in. thick and a foot square, nailed to the bottom of the upright in such a manner that a larger bearing area will be secured. Stones or bricks should never be used under uprights in any kind of a scaffold as they are very easily knocked from position by trucks or material bumping against the uprights.

**Suspended Scaffolds.**—Pole and independent pole scaffolds are generally used for buildings up to about 6 stories in height. Above this height the construction of these scaffolds becomes a large item of expense, and there is also a greatly increased element of danger connected with high scaffolds due to the great weight coming upon the bottom uprights. On high buildings it is now customary to use suspended scaffolds, which usually consist of substantial platform planks resting upon putlogs, each end of which is suspended by means of a cable hung from an overhead beam projecting from the building. These scaffolds are usually equipped with means for raising and lowering the platforms, which consists of a machine for each cable with a drum and means of winding up the cable.

There are two principal types of these scaffold hoisting machines: on one the winding drums are located on the platform, and on the other these drums are located on the beams overhead. Advantages are claimed for both systems, and no attempt will be made here to justify the use of one over the other. The first type is worked usually by a lever and ratchet operated directly on the cable drum on the platform; the other is operated by means of worm gears and a sheave wheel driven by a tiller rope which extends within reach of the men on the platform. These scaffolds are usually provided with cables approximately 100 ft. long, and where it is necessary to work beyond this range, the scaffold is relocated to a new position above after the cable is wound up.

Suspended scaffolds should never be used without guard rails and toe boards on account of the great height at which they are operated. It is also advisable to fill in the space between the guard rail and toe board with substantial netting having openings no greater than ½ in.

**Outrigger Scaffolds.**—At certain places, such as under big cornices and for other special construction, platforms are often placed upon beams thrust out from the building. These beams should be of substantial dimensions and excellent quality, and they should be rigidly fastened on the inner ends to floor beams or substantially braced against overhead beams. No dependence should be placed upon these cantilever beams being simply fastened into the wall; they should project inside of the building to some considerable distance and there be securely fastened. Guard rails and toe boards should always be used with this type of scaffold, and the planks should be provided with the same consideration as used for laying the planks in pole scaffolds. These scaffolds are not recommended where it is possible to use one of the other types.

**Carpenters' Bracket Scaffolds.**—With the carpenters' bracket scaffold, platform planks are placed upon brackets, which consist of horizontal and vertical members, usually about 4 ft. long, and a diagonal member to provide the necessary bracing. These members are bolted together in a substantial manner, and the bracket is placed on the building with its horizontal member perpendicular to the wall. It is held in that position by a bolt anchored at the inner end of the horizontal member, extending through the wall, and bolted on the inside. This bolt, usually about ⅝ in. in diameter, should not be simply bolted through the sheathing, but should project through a substantial block that extends across the inside of the studs.

There should be sufficient brackets in order that there may be three under each plank. Thus with 16-ft. planks, the brackets should be no further apart than 7 ft. 6 in., in order that the planks may overlap each other about 1 ft. over every alternate bracket. This type of scaffold does not adapt itself very readily to the installation of guard rails and toe boards. These rails and toe boards may, however, be installed without much trouble, and where the scaffold is used more than 10 ft. above the ground, they should certainly be erected. It is a very common practice to lay the platform planks upon these brackets in such manner that the points of overlapping do not always come upon a bracket. This forms a blind trap, and under certain conditions may result in a man being precipitated to the ground below, should he place his entire weight upon the unsupported point of overlapping.

**Painters' Scaffolds.**—The painters' scaffold consists of a ladder-like platform having parallel sides but somewhat wider than an ordinary ladder, each end of which is suspended by a triangular stirrup. This stirrup is usually made of $^3/_4$-in. wrought iron or steel, and at the upper or apex corner the metal is in the form of a smooth loop for the reception of the hook of the lower hoisting rope block. The upper block of the hoisting rope is held by a large wrought iron or steel hook, about $^5/_8$-in. diameter in cross section, which is hooked over the cornice of the building in a substantial manner. The stirrups should have appropriate brackets for the installation of guard rails as well as toe boards, and it is noted with a great deal of satisfaction that this type of scaffold is being provided with these rails more generally now then several years ago. The scaffold is raised or lowered by the men on the platform, and the free end of the rope is deftly looped under the rounded apex of the stirrup and over the hook in such manner that the platform is held in position without any further securing of the rope.

The loose ends of the rope below the fastening should be protected from injury or tampering by unauthorized persons on the ground and it is a good plan to coil this free portion of the rope upon the platform. Projections in front of the platform, with rollers on their ends, bear against the side of the building and determine the distance that the platform shall have therefrom. Where the distance from the platform to the point of support overhead is great, the scaffold should be lashed to the building in a substantial manner in order that it will not swing away from the building and thus present a considerable hazard to the workmen. When the men leave the scaffold for any length of time, they should either lower it to the ground, or at least lash it securely to the building in such a manner that it will not be blown about by the wind. Buckets and other tools should not be left on the scaffold as they may fall to the ground below with possible injury to persons. No more than 2 men should regularly work on one painters' scaffold, and no more than 3 men should ever be on the scaffold at any one time. Several painters' scaffolds should not be combined by bridging the spaces between them with planks in order to cover a greater amount of the building with a small number of scaffolds.

**Needle Beam Scaffolds.**—Needle beam scaffolds are used largely for riveting steel work on buildings and for working under roofs. It consists of a plank platform resting upon two beams which are suspended at each end by means of ropes. Where beams span from 10 to 12 ft., they should have a cross section of at least 4 by 6 in.; for larger spans, larger beams accordingly should be used. Great care should be used in the placing of the platform planks. The beams should be parallel, and in case local conditions require that one beam be lower than the other, the platform planks should be provided with bolts in each end to prevent them sliding over the beams. It is best practice in any event to have the platform planks always fitted with these bolts placed about 6 in. from each end. In some cases guard rails on this type of scaffold may be a hazard instead of a help. Where the work consists of swinging a maul or a sledge, the guard rail may promote an accident instead of preventing it.

**Plasterers' and Decorators' Scaffolds.**—Plasterers and decorators' working on large interiors, usually operate from scaffolds designed somewhat similar to independent pole scaffolds. These cover the entire floor in order that access to the ceiling may be had as well as to all the walls. For very large areas, scaffolds are usually constructed around the 4 walls of the room, and suspended or needle beam scaffolds are hung from the ceiling. In erecting the side scaffolds the same precautions should be taken as with the construction of independent pole scaffolds. The parts should be well braced, and the same care should be taken as to the installation of guard rails and toe boards. There is a difference of opinion as to how the platform planks should be laid overhead. Many authorities believe that it is satisfactory to permit a space of 6 in. to a foot between the various planks, assuming that the men will not fall down through such a space. This, however, does not prevent tools or material from falling to the floor below and possibly upon persons, and it is more desirable that the platforms be built solid, particularly at the points where the men do their work. For lower ceiling heights horse scaffolds and ladder scaffolds may be used.

**Horse Scaffolds.**—Horse scaffolds consist of strongly made trestles over which platform planks are placed. They are used largely by stone masons for both inside and outside work. The work is first carried up about 5 ft. from the base, after which a platform is erected with horses about 4 ft. high, together with the usual platform planks. When the work is again carried beyond reach of the men, another horse scaffold may be erected upon the first, care being taken to see that the horses are placed directly one above the other. It will not be necessary to leave all of the platform planks upon the first scaffold. The outside planks, or those upon which the legs of the horses rest, should remain in position, and the others may be removed for use above. If the work is being done inside, it is possible that the men may reach the ceiling without erecting any more tiers, and the work may then be carried on from the floor above, provided the building is of steel construction and the floor beams have been constructed before the side walls. There are cases where builders erect horse scaffolds in 6 or even 8 tiers high, but we do not consider it advisable to go beyond 3 or 4 tiers. It is not an uncommon sight to see bricks or other material under trestle legs, and in such a case there is needed only a slight jar to upset the whole scaffold. It is advisable that, where these scaffolds are erected in tiers, the trestle legs be nailed to the planks upon which they stand. This will give increased strength to the scaffold and help to prevent its collapse due to vibrations caused in any manner. A scaffold of several tiers should also be braced against the side of the building, or by diagonal braces from the floor.

**General Requirements.**—The lumber used in scaffolds should be either spruce or long leaf yellow pine; hemlock should not be used as it is too brittle. All parts should be free from defects such as injurious ring shakes and cross grain or unsound knots. Nails should be of the best quality, and they should be driven full length, the bending over of partially driven nails being poor practice. Cables used with suspended scaffolds should be not less than $^1/_2$ in. in diameter; they should be plow steel, 6 strands, 19 wires, and have a factor of safety of at least 5. They should be galvanized to order. Steel ribbon should not be used for suspended scaffolds as it is more liable to break and is easily kinked. Where rope is used it should be of the best manila grade, and, where it passes over sharp corners, it should be protected from abrasion by padding or other suitable means.

Where scaffold uprights are spliced, they should be butted together and at least two boards, about 4 ft. long, should be nailed on two adjacent sides. The splices on adjacent uprights should not be at the same level, but should be staggered. Where fixed ladders are constructed on scaffolds, they should extend about 45 in. above the platform, in order to facilitate the landing of the workmen. Single pole ladders should not be used. Where the scaffolds are to be used a long time, it is preferable to construct stairways having full treads and substantial railings. Runways to platforms should not have a greater rise than 1 ft. in each 2 ft. of length. Where the rise is greater than 1 ft. in 5 ft. of length the runway should have cleats nailed thereon about 8 in. apart to prevent slipping. The center portions of the cleats may be omitted in order to provide a wheelbarrow track.

Where necessary, overhead protection should be provided for persons or workmen about scaffolds in order to catch falling objects. Where a sidewalk under a scaffold is kept in service, it should of course be entirely bridged over with substantial material. All doors being used on ground floors of building should have ample protection over their entrances. Suspended scaffolds should also be equipped with either heavy canvas or heavy wire netting covers where used with tall buildings, in order to protect the workmen on the scaffolds.

Consideration should be given to the use of life lines and safety belts for men working on thrust-outs and high elevations. These, however, should be used with caution, as they may in certain cases hamper the workmen and possibly promote accidents. In large auditoriums having high ceilings, and also for structural iron workers operating at great heights, safety nets are often used advantageously to catch workmen should they fall. These nets should be constructed of at least ½-in. manila rope having meshes no larger than 4 in. square and borders of at least ¾-in. rope.

**Falsework.**—A great deal of the foregoing material applies to the construction of falsework. This class of construction cannot be standardized to the same extent as scaffold work, hence it will be impracticable to give, in detail, specifications for safe construction. Whether the falsework is erected to support a stone or brick arch, or partakes of the elaborate work used in the building of some of our modern masonry and concrete bridges and similar structures, it should in every case be given careful treatment, and be designed according to the stresses to be met. In most cases it will be necessary to make drawings giving as much detail as if the structure were a permanent one.

Only the most experienced men should be entrusted to the construction of this class of work, and propositions of large dimensions should be handled as faithfully as though the structure were going to be a permanent one. In the design and construction of all falsework, great consideration should be given to the method of its removal after it has served its purpose. False centers should be so designed that, by collapsible keys or other means, they may be removed without straining or damaging the permanent structure.

# Test of Rock Foundation for Concrete Dam

Preliminary to the construction of the Government lock and dam at Troy, N. Y., a thorough test was made of the rock foundation. The methods employed in making this test were described by Mr. A. C. Harper, assistant engineer, U. S. Engineers Department, in the July-August Professional Memoirs from which the following notes are abstracted.

At the site of the dam the "Middle Trenton" shale is found. The surface and character of the rock were approximately determined by borings made with jump, hand driven, and calyx drills. Results of the borings indicated a very uneven surface of seamy rock and large boulders. The amount of core obtained by the calyx drilling was, in most instances, so small in comparison with the depth of the hole that it gave little or no definite data as to the strata or structure of the rock. Some of the samples were hard and compact but most of them disintegrated more or less when exposed to the action of air.

About 3,000 sq. ft. of rock, at the site of the shore end of the west arm of the dam, was uncovered and exposed to air for a period of about six weeks; during which time tests were made by forcing air and coloring matter, under 60 lb. pressure, into the rock through a 2 in. drilled hole 14 ft. deep, and for resistance to pull, on steel rods cemented into drilled holes. An examination of the surface, for roughness, structure and strata was also made.

The test holes were hand drilled on 10 ft. centers and with the exception of the one to which the air tests were applied were from 4 to 6 ft. in depth. The drilling of the 14 ft. hole indicated no material change in the rock structure after penetrating the compact surface crust, which is about 3 in. thick. A stream of sulphur water was encountered, at a depth of 10 ft., which rose in a pipe to a height of 6½ ft. above the surface of the rock and maintained a constant flow. It was piped to a point beyond the downstream face of the foundation.

The compressed air tests indicated fissures; but an attempt to force discolored water through them was unsuccessful.

The tests made by pull on anchor bolts indicated that the rock might safely be depended upon to develop its full strength. The steel bolts used were made of the "Kahn" bar, 1 in. section; they were cemented into 2 in. drilled holes with neat Atlas cement grout. The lower ends of the rods were upset and the upper ends bent and welded, forming a 4 in. eye. The full was made by a 24 in. by 20 ft. I-beam used as a lever; the weight applied being sand in bags weighing 100 lb. each.

Test No. 1—

Depth of hole, 6 ft.
Cement grout, 19 days old.

Slight radical cracks appeared in the surface of the rock with a pull of 35,500 lb., slightly increasing in size to a width of ⅜ in. with a pull of 40,000 lb. when the weld of the bolt eye failed.

Test No. 2—

Depth of hole, 4 ft.;
Age of grout, 25 days.

The welded eye of the bolt failed with a pull of 45,500 lb. and the surface of the rock showed one very slight radial crack. The bolt was reshackled and the pull increased to 46,000 lb. at which the bolt itself parted.

Test No. 3—
Depth of trap, 3½ ft.
Grout, 2 [illegible] old

With a pull of 72,000 lb. the pulling rig failed. The test showed at [illegible] elongation and no cracks appeared in the surface of the road.

The surface cracks in test No. 1 were very likely due to the failure of the cement grout.

## Directory of the American Association of Engineers

The first directory of the American Association of Engineers has just been issued from the national headquarters at 29 South La Salle street, Chicago. The publication is a considerable improvement over the ordinary society year-book. In its publication the aim has been to make a directory that would be an actual engineering service guide. The directory gives a brief synopsis of each member's experience and training, which will be of definite usefulness to the employer of engineers, who will be able to tell whether an applicant fills his needs without the loss of time from unnecessary interviews.

Classified tables have been compiled based on experience, so that it is possible to find a consulting engineer, an executive or a subordinate having specific experience and living in any definite locality. Thus if one needs a consulting hydraulic engineer, or a designer of machine parts, he is able to find men having this experience through the aid of the classified tables.

The 2204 members registered in the Directory are divided according to experience, as follows:

| | [illegible] |
|---|---|
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |

The membership is divided as follows:

| | [illegible] |
|---|---|
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | 0.5 |
| [illegible] ls, managers, superintendents, etc.) | 40.4 |
| [illegible] men, etc. | 42.5 |
| [illegible] | [illegible] |

Over 20 per cent of the members of the A. A. E. are on the Association's Service Roll.

The Directory is bound in cloth, is 6x9 in. in size and contains 192 pages. It sells for $2.

## Dragging Tractor from Mud Hole

A bull wheel tractor stuck in a mud hole from which it could not extricate itself with its own power was pulled out in the following manner: Brush was placed in front of the bull wheels to form a hold for the strakes. The cylinder cocks of the engine were opened, and the clutch thrown in. A stout rope about 100 ft. long was then wound around the power wheel and one end hitched to a team of horses. The horses unwound the rope, their pulling power being applied through the driving gears. It was necessary to repeat the operation several times before the tractor was clear of the hole.

**China Borrows $20,000,000 for Railway Construction.** An agreement for a loan of $20,000,000 for construction of the Kirin-Huining Ry. has been signed by the Chinese Minister of Communications, and representatives of Japanese banks. The proposed railway will extend from Kirin to Huining, in Korea, a distance of about 277 miles.

# The Part Played by Engineers in the War*

By MAJOR JAMES E. CASSIDY.

The corps of engineers in this country at the outbreak of the war consisted of 200 officers and 2,100 enlisted men. Our organization today consists of 252 regiments and about 108,000 men and 7,000 officers. For 14 months that is not bad, and our proportion is increasing all along. In the time at my disposal I can merely mention the different activities in our Army that have been turned over to the engineers.

For instance, we have the work of mining and sapping; the various classes of bridge work—pontoon and other classes used in the field; and the mining of deep gallery shelters, a very important feature on the fighting fronts of today in the war of positions. For several miles from the front lines all the soldiers live in deep gallery shelters. With the modern high-angle artillery fire one is not perfectly safe in a deep gallery shelter unless he has from 25 to 30 ft. of roof over his head. Major Rosseau of the French engineers, in commenting on that point, stated that often a mistake was made in constructing a machine-gun shelter with only 4 or 5 ft. of earth overhead, and said that a piece of sheet iron would serve equally as well, because neither would turn even the smallest shells.

The work of demolition and the defense against the poisonous gas used by the Germans has been turned over to our engineer service. Then we have the searchlight service and camouflage paint service. We have not progressed so very far in tanks yet, but have a tank corps organized and tanks under construction or under contract. We have a railway transportation regiment which has been turned into a corps, and the gas and flame offensive service. Then we have the map section of the engineers and quarry regiments to quarry and crush stone for road work. One of the primary things of the war today is getting up supplies; and the building of railroads and ordinary highways has involved figures that are staggering to the ordinary individual. Then there are tunnel companies for various kinds of tunnel work, mostly back in the zone of the interior.

**Cantonment Construction Abroad.**—With reference to cantonment construction abroad, I would say that most of our troops are billeted in France. For instance, a certain village will have every house and every barn marked with the number of men it will accommodate and the town major has a complete list of every house, knows exactly where he can have his headquarters and knows how many a certain building will shelter. I believe the usual basis of figuring that billeting is about seven soldiers to one civilian inhabitant. In our training areas back behind the lines, however, we build cantonments differently from what we do in this country. Here we have simply let contracts for the erection of buildings; for use abroad we have furnished portable, or rather, section houses. The original design was for houses 20 ft. wide and 237 ft. long. The doors were put on a panel, the windows were put in and the roof was in sections. The only thing not built up here was the floors. The work was parceled out to 15 mills and enough of these buildings were completed in 60 days to house 500,000 troops.

**Water Supply, Road and Railway Regiments.**—The large army of today not only needs plenty of food supplies and ammunition, but it needs water as well. So we find the Germans poisoning wells and dropping in bodies of animals and men or anything to destroy the value of the water for immediate use, making it necessary for the engineers to plan for a water supply to follow the armies, run pipe lines, dig wells, and take steps for purifying water. Then we have our general construction units which do all sorts of general construction work back in the zone of the interior. We have the general repair shops and supplies. We have railway-construction regiments. There is one particular regiment—the 23d Engineers—that is organized for highway work and will ultimately have under its direction an immense force of German prisoners. In the 32d there are men serving as privates who have had 10 or 15 years' engineering experience, consulting engineers, some of them. You will find there almost every class.

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*[illegible]

Our railway engineering corps is very elaborate. We have the standard-gage construction and operation men. We have the 60-cm. units and the 40-cm. The 40-cm. are light railways that are built up in the trench lines, leading up to the front lines, and the 60-cm. are back of them. The 40-cm. lines are entirely for small cars moved by hand. The 60-cm. cars are partly horse-drawn and partly drawn by small locomotives, either gas or steam. We have sent over a great number of cars and engines. Our equipment in this country is very much heavier than the standard equipment in Europe, and where we can use our engines and cars without going through tunnels, we send our equipment. Then to keep up this railway work we have our railway shop regiments, of which there are quite a number. Then of course we have field fortification and fortification in general, and recently aerial photography has been turned over to the engineers. It seems that when they run into anything that nobody else wants particularly they immediately put it on the engineers!

**Taking Messines Ridge by Engineers.**—Any one of these different items is a story within itself. In regard to some of them I probably could spend an hour talking on one particular feature, but I want to mention a few things that have come under the scope of the engineers, for instance, in taking Messines Ridge. For 14 months before this attack was made the British were busily engaged tunneling this hill, running mine galleries. There were 24 of these mine galleries and their average length was over two miles. These galleries were about 4 ft. by 6 ft. and as the earth had to be carried out and disposed of so that the Germans would not know any more about what was being done than possible, it was quite a tedious task. The Germans knew that the British were mining this hill, although they could not tell where. Owing to the geological conditions of this particular terrain there was a stratum of clay above the British tunnels acting as a muffler, and while the Germans could tell by the sounds that there was mining going on, they were not successful in doing any countermining. The idea is that when any one is running a mine gallery up to your trenches, you should countermine and blow him out with what is known as a counterflame; that is, a small shaft that runs into his mine. The British played a little joke on the Germans. The Germans were holding Messines Ridge as lightly as possible, knowing that tunneling was going on, but not being able to locate the mine galleries. These mine galleries were eventually finished and branched out in different directions under the German lines, and a 1,000,000 lb. of aminol was placed in them. This aminol, which is very much of the same nature as our TNT, was put into rubber bags and these bags were placed about four months before they were detonated. The British played their little trick by placing their mines and then waiting for an opportune time, because the Germans, after the British stopped digging, got over their scare. It is rather trying on the nerves to know that some one is mining under you and you are unable to find him—it shakes the morale of the best troops. So there was a period of about four months that they waited after the mines were laid and the Germans had gotten over their nervousness and Messines Ridge was held very strongly. Then one morning, at exactly 4 o'clock—and I might say in this connection that very great care is always taken in any sort of movement to see that all watches are absolutely synchronous; every watch must be exactly with the others, there must not be 30 seconds' difference—the 1,000,000 lbs. of aminol was exploded and every gun on the British side started firing. The whole top of Messines Ridge was practically blown off, and the country seemed to rock for about 10 minutes. The British troops moved forward without very many casualties. The Germans were simply stunned by the artillery fire and the explosion of those mines. Following the explosion of the mines a novelty was introduced in the way of machine-gun barrage, the Royal Engineers having placed machine guns about 1,800 yd. behind the British positions.

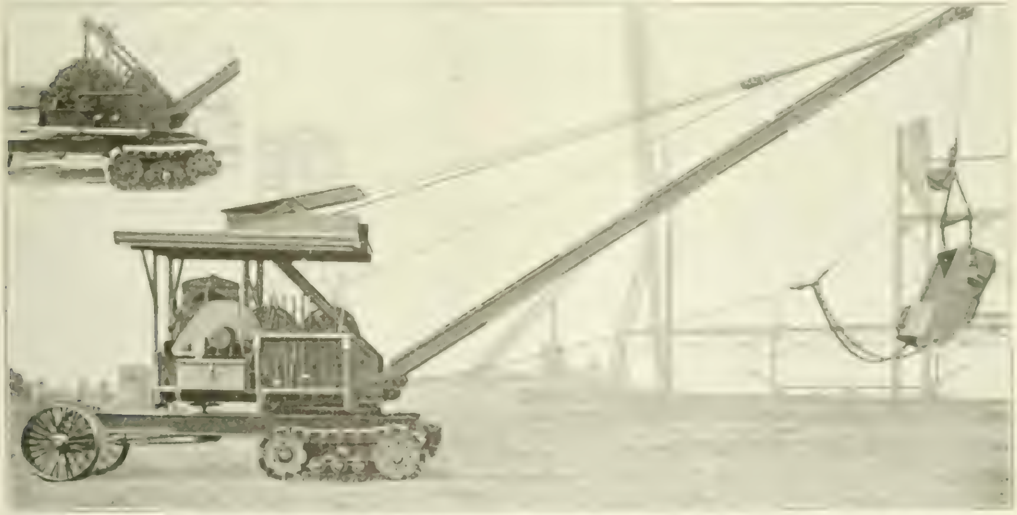
The Italians performed a similar feat in the Col di Luna in the Dolomite Alps. Those peaks are very jagged and the Austrians held a post on a small peak that the Italians could not get at. On January 16, 1916, they had prepared to go after this peak and they moved in compressed-air and other necessary machinery under the shelter of a ledge, some 4000 ft. below the Austrians who were up on the top of this peak. They started their tunnel, ran it up at an angle of 45° for about 4000 ft. to get under the Austrian position and spread out in a sort of fan shape and placed 95 tons of aminol under this position. On July 16 they exploded the charge and there was nothing left of the Austrian position, not even the top of the peak. The whole top of the mountain was removed.

## Course of Study for Students Training Corps

The course of study for student-soldiers of the Students' Army Training Corps now being organized in the colleges of the country as an active branch of the Army, is announced as follows by the Committee on Education and Special Training of the War Department: In the curriculum of the Students' Army Training Corps, the average number of hours each week will be as follows: Subjects including practical and theoretical military instruction and physical training, 11 hours a week; allied subjects including lectures, recitations, laboratory instruction and the preparation needed for such work, 42 hours a week. These hours are set forth with reference to the normal course period. In the case of students who have had at least one year at an approved institution, during which they have specialized in studies which form part of the preparation program for Chemical Warfare, Medical Corps, Engineer Corps, the Ordnance Corps or other technical branches of the service, the Committee on Education may authorize a reduction in the hours of military training to not less than six hours a week. This is only in the event that additional number of hours be given to the study of technical subjects. Ordinarily the allied subjects selected for the Students' Army Training Corps will be English, French, German, mathematics, physics, psychology, chemistry, biology, geology, geography, topography and map-making, meterology, astronomy, hygiene, sanitation, descriptive geometry, law, military law and government. Permission may be given for the recognition of one other subject provided that it requires not more than three hours a week in lectures and recitations. The presidents of the colleges which have been authorized as units of the S. A. T. C. have been adived that the Collegiate Section is confined to students graduated from standard four-year, secondary schools or students having the equivalent of such educational qualifications.

## Drag Line Excavator and Back Filler Has Many Uses

A small portable drag line machine of wide adaptability has been placed on the market recently by the Pawling & Harnischfeger Co., Milwaukee, Wis. The machine can be used for backfilling after the largest size of trench excavators, for general drag line work and for handling screenings, crushed rock, etc. It also can be used as a portable locomotive crane. In the latter capacity it can lift 3,500 lb. at 30 ft. radius, and can be used for unloading materials from cars, placing pipe in trenches, pulling piles, etc. This backfiller and dragline excavator is regularly equipped with a 40-ft. boom and 6-ft. wide self-acting backfilling scraper. Boom extensions for increasing the length of boom up to a total of 50 ft. can be furnished at additional cost for backfilling only, if required. The standard machine with 30-ft. boom will also handle either a $\frac{1}{2}$-yd. drag scraper bucket, or a $\frac{1}{2}$-yd. clam shell bucket. These parts with their attachments are furnished at additional cost. The machine weighs 13 tons and has a traction speed of 0.85 mile per hour. It is driven by a 4-cylinder vertical 30-HP. motor of the internal combustion type. The corduroy bearing surface is 18 in. by 5 ft. 6 in.



P & H Class 205 K C Dragline Excavator and Backfiller Equipped With [illegible] Scraper Bucket on 30 Ft. Boom.

## Engineering Position Now Open

Transitmen, rodmen, structural and mechanical draftsmen are wanted for the civilian personnel of the War Department. Among the other engineering positions now open, listed by the Division of Engineering of the U. S. Employment Service are the following: Twenty-nine draftsmen for work with a railroad company in Illinois. Five young mechanical engineers, graduates in a course in mechanical engineering of the U. S. Employment Service are the engineer in charge of levee building in Louisiana. (Civilian position with the army.) One draftsman experienced for detailing and checking steel buildings and bridges in Nebraska. Draftsmen who are able to prepare drawings from civil engineers' notebooks. Civilian service in military work—men of draft age may be inducted into this service. If they show promise they will be given opportunity to go through the Ordnance School to qualify for commission. One mechanical engineer to act as assistant on river and harbor work. Must be graduate in mechanical engineering and be familiar with testing boilers, machinery and furnaces. Location in Southern states. Salary, $250 and subsistence.

For detailed information and registration blanks application should be made at once to A. H. Krom, Director of Engineering, 29 S. La Salle St., Chicago. The Division of Engineering is in direct touch with all important military, governmental and industrial activities relating to technical affairs. The Division gives its services free of charge to all engineers, employers and technical men who register.

**Water Power Bill Passed by House.**—The House of Representatives on Sept. 5 passed the Sims water power bill, providing for the granting of licenses to private companies for the development of power from navigable rivers in public lands. A similar bill has been passed by the Senate and the two bills will now be considered in conference.

# News Letter

## St. Louis Items.

B. F. Brooks, Clio, Ia., is about through there. Wants another grading job.

Wm. Dankliff is grading a small job for the Wabash R. R. near Mt. Olive, Ill.

Jansen & Schaefer, Pekin, Ill., have a 14-team outfit, tractor and elevating grader idle.

Keating Bros. are reducing grade on the Chicago & Illinois Midland R. R. at Auburn, Ill.

P. J. Murphy has moved one of his team outfits to a new job on the Wabash R. R. at Dalton, Mo.

Cameron, Joyce & Co. were awarded some team work by the Rock Island R. R. near Trenton, Mo.

Tom Campbell has taken 90,000 yds. of work on the Santa Fe R. R. at Chilocco, Okla., from L. E. Dollman.

Lightning killed a skinner and a mule of the J. W. McMurray contracting job at Camp Funston, Kan., the other day.

A. A. Luck has his outfit at work at Harrisburg, Ark. Says he has a nice job there and enough to hold him for some time.

Cook-O'Brien Const. Co. were awarded the second track work between Winfield and Arkansas City, Kan., by the Santa Fe R. R.

J. C. Kaiser expects to finish his levee work at McClure, Ill., in a few days. Will have a cracker jack machine and grading outfit idle.

J. C. Parquette, 206 E. Walnut St., Des Moines, Ia., writes us that he is in the market for a grading job that will fit a 20-team outfit.

F. E. Gray is moving his outfit on to some bank widening work on the Rock Island R. R. near Leighton, Ia. Gray subbed this job from A. L. Cook.

Contractors when in want of labor or work for their outfits write Koenig's Labor Agency, 612 Walnut St., St. Louis, Mo., or 503 Delaware St., Kansas City, Mo.

C. S. Jones, the boss stationman, has taken 50 miles of bank widening on the Katy R. R. between Denison and Greenville, Tex., from the A. L. Cook Const. Co.

On account of being in the draft, Jas. B. Swift, 800 S. Spring Ave., is going to sell his grading outfit, consisting of 10 teams, wheelers, machine and dump wagons.

Harrington Bros. secured the contract for grading a spur and yards for the Old Ben Coal Co. at West Frankfort, Ill. They have about 20,000 yd. of nice team work to sublet on this job.

F. D. Sullivan, of the Walsh Construction Co., passed through St. Louis the other day on his way to La Rue, O., where they have quite a job of double tracking for the Big Four R. R. Co.

The Eby Const. Co. have resumed work on the Katy yards at Appleton City, Mo. This work was shut down some time ago by the company after being taken over by the Government.

Thos. L. Rosser, Jr., has one of his outfits at work on force account on the Illinois Central R. R. near Dawson Springs, Ky. Also has another shovel outfit on the Rock Island R. R. near Trenton, Mo.

R. T. Amis is moving a part of his team outfit from Allerton, Ia., onto a new job that he subbed from Cook-O'Brien Const. Co. on the Santa Fe R. R. near Augusta, Kan. Amis also has an outfit at work at Winfield, Kan., on the same road.

Clark & Jackson have about finished their rock work on the Katy R. R. at Augusta, Mo., and moved a steam shovel to Omaha, where they secured a contract from Condon Bros. to load 100,000 yd. of dirt for the new yards the Union Pacific is building at Council Bluffs, Ia.

No St. Louis items last month on account of the writer being laid up for five weeks with malaria that he contracted on his last fishing trip down in Arkansas in the early part of July. With the exception of a loss of about 30 lb. in weight he is as good as ever again and is including some of the most interesting August items in this issue.

Mulvill Bros., Carlinville, Ill., have 6,000 yd. of work on the reservoir at Blackburn, Mo., to sublet. This work is suitable for fresnos or can be done with an elevating grader and wagons. It is mostly all side borrow and consists of making a levee embankment and county highway. In addition to this Mulvill Bros. have several grading jobs suitable for small outfits to sublet.

The Austin Company, of Cleveland, O., started work on one of the big Government ammunition plants to be built by the Laclede Gas Light Co. in the southern part of the city. The largest of these buildings will be a thousand feet long and 300 ft wide. In this building shell forgings or slugs will be finished into the completed shell. All of the buildings will be of steel construction and when completed will be one of the largest ammunition factories in the United States.

Baxter L. Brown received a letter from his son, Lieutenant Lee M. Brown, that he was severely wounded on July 18th. A later letter, however, gives a reassuring account of his condition. Lieutenant Brown writes that his good right arm stopped a German machine gun bullet. The bullet went in at the shoulder and came out just above the elbow. Says he is feeling fine with the exception of his arm, and is being treated wonderfully by the French nurses, who are doing everything they can for the comfort of wounded Americans.

Maj. John R. Fordyce, of the Army Engineer Corps, a St. Louisian, who supervised the construction of the new warehouses at the Arsenal in St. Louis and the building of the army cantonment at Camp Pike, Ark., has been assigned as advisory engineer for the construction of the terminals for the new barge line between St. Louis and New Orleans. He has opened offices in the Third National Bank Building, and immediately will take up the terminal situation with city officials with a view to completing dock facilities for early river traffic. It is expected boats will be in operation this month. Director-General McAdoo has approved the purchase of two tow boats and nine steel barges from the Kansas City River Navigation Co. for use on the lower Mississippi, and the purchase of warehouse properties in East St. Louis from the same company.

A Government order prohibiting the sale of cement to consumers except under pledges that the material will not be used for purposes not included in the essential list of war work will hamper the completion of several street improvements in St. Louis, President Kinsey of the Board of Public Service said. Kinsey wired to the officials at Washington asking permission to purchase cement to complete the street paving now under contract and almost finished. Kinsey said the service Board will halt all proposed street and alley improvements and construction of sidewalks until a definite ruling is made specifying what municipal work is essential. About 12 contracts for street and alley improvements now are under way, he asserted, and could be completed in period ranging from four days to two weeks. Director of Streets and Sewers Talbert said that in his opinion the repair of streets and alleys should be classed as essential, and that unless such a ruling is made many of the St. Louis streets will deteriorate from constant use and will be almost impassable for vehicles.

A. B. KOENIG.

# Personals

W. H. Kirkbride has been appointed chief engineer of the Southern Pacific—Pacific System Lines south of Ashland.

T. J. Wyche has been appointed chief engineer of the Western Pacific R. R., Tidewater Southern R. R. and the Deep Creek R. R.

C. N. Brainbridge has been appointed assistant engineer in charge of bridge inspection and bridge erection for the Chicago, Milwaukee & St. Paul Ry., vice Mr. E. S. Moloy, deceased.

Theodore S. Bean, who was connected with the engineering department of the C., P. & St. L. R. R. for a number of years at Springfield, has been appointed engineer in charge of the field valuation of the same road, with offices at Bloomington, Ill.

Charles A. Morse, formerly chief engineer of the Rock Island, and now president of the American Railway Engineering Association, has been appointed assistant director of the Railway Administration's division of operations, in charge of engineering and maintenance.

Following engineering appointments have been made by Federal authorities for Union Pacific R. R. properties: R. L. Huntley, chief engineer, Omaha, Neb.; Carl Stradley, assistant chief engineer, Salt Lake City, Utah; W. R. Armstrong, engineer maintenance of way, Omaha.

H. S. Noble of Buffalo, N. Y., vice-president of the Great Lakes Transit Corporation, has been appointed federal manager of the New York State Barge and New Jersey Canals, operated by the railroad administration, to succeed G. A. Tomlinson, who becomes director of a new division of inland waterways.

J. B. Myers, formerly division engineer of the Baltimore & Ohio R. R., has been appointed chief engineer of the maintenance of way of the Allegheny district under the United States Railroad Administration. Earl Stimson, who was chief engineer of the Baltimore & Ohio, with headquarters in Baltimore, is now general superintendent of bridges and buildings for the Allegheny region.

Guy E. Tripp, formerly colonel United States Army and head of Production Division, has been made brigadier general United States Army, and placed in offices having charge of the production of ordnance material in their respective sections of the country. The district chiefs will report direct to General Tripp, who is succeeded as head of the Production Division by Colonel C. C. Jamieson. Previous to his connection with the ordnance department, General Tripp was chairman of the board of directors, Westinghouse Electric & Manufacturing Co., with headquarters in New York.

Mr. Louis J. Horowitz, formerly president of the Thompson-Starrett Construction Co., New York, has been appointed as special assistant to the chief of ordnance in charge of tanks. In this capacity, Mr. Horowitz will have authority to decide all questions pertaining to the engineering and manufacturing and inspection of tanks. Brigadier General John T. Thompson, U. S. A., retired, in addition to his duties as director of Arsenals and Advisory Engineer, has been made director of ordnance training. Captain S. E. Blunt, U. S. A., has been appointed employment supervisor and will work in conjunction with the commanding officers of the several arsenals and other ordnance establishments to secure the necessary personnel for their efficient operation.

Captain J. J. Gaillard is now District Engineer in charge of the Atlanta, Ga., office of the Portland Cement Association, succeeding W. Jess Brown, who resigned to accept a commission as captain in the Ordance Department, U. S. Army. Captain Gaillard joined the forces of the Portland Cement Association Jan. 1, 1918, and since that time has been doing general promotion and inspection work in the district covered by the Atlanta office of the association. Captain Gaillard is a graduate of the North Georgia Agricultural College, having the degrees A. B. and C. E. Previous to joining the staff of the Portland Cement Association, he was, from 1912 to 1917, City Engineer of Macon, Ga. Under Captain Gaillard's development of concrete street pavements at Macon, the practice of finishing concrete with the paving roller was inaugurated and this has since become standard practice.

# Trade Publications

The Universal Road Machinery Co., Kingston, N. Y., has issued two circulars, one devoted to the Reliance fine crusher, and the other to stone and ore crushers, elevators and screens. The first mentioned circular contains useful suggestions on the application of the crusher to various classes of work.

A pocket text book called the Blasters' Handbook has just been issued by E. I. du Pont de Nemours & Co., of Wilmington, Del., which tells how to use explosives for every purpose where their employment is practicable. The book gives valuable information regarding the proper explosive to use, the quantity, the method of loading and firing. It is profusely illustrated and contains charts and diagrams that make this work a valuable addition to any technical library. It does not go into exhaustive detail in many cases, but cites references to other books, published by the Du Pont Co. These books are: High Explosives, Sections 1 and 2, which gives detailed information on high and low explosives. Blasting Supplies, which covers fully the subject of blasting supplies and their uses. Blasting Powder, which describes the uses of blasting powder. Road Building and Maintenance, a treatise on road building. Shale and Clay blasting, on mining clays. Pole and Post Holes, on digging them. Handbook of Explosives, on a variety of uses, especially in drainage and land clearing. Any of these can be had free of cost, by those interested in blasting, by addressing a card to the Du Point Co.

*Building and Structural Monthly Issue*

**ENGINEERING AND CONTRACTING**

HALBERT P. GILLETTE, *President and Editor.* LEWIS S. LOUER, *Vice President and General Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering field. See advertising page for further information and [illegible]

**Roads and Streets—1st Wednesday**
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies

**Waterworks and Hydraulics—2nd Wednesday**
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power

**Railways and Govt. Works—3rd Wednesday**
(a) Excavation and Dredging (c) Harbors and Docks
(b) Rivers and Canals (d) Railway Construction

**Buildings and Structures—4th Wednesday**
(a) Buildings (c) [illegible]
(b) Bridges (d) Miscellaneous Structures

Volume L CHICAGO, ILL., SEPTEMBER 25, 1918 Number 13

# Why Does the Government Give Scant Recognition to the Structural Merits of Lumber?

In a recent newspaper article it was stated that one of the American terminals in France has 180 warehouses capable of housing a million tons of goods and machinery. Almost half of these buildings are of steel. If these steel buildings were ordered prior to the time that it was realized there would be a shortage of steel no criticism should be made except as to governmental failure to forecast the demand for steel. But if, as we think more probable, this immense tonnage of steel was ordered for these warehouses subsequent to the initial shortage in steel, the act is open to the severest criticism.

That our steel output is not susceptible of very rapid increment is well known. It should be equally well known that our output of lumber can be increased enormously in a comparatively short time. For example, when the Spruce Production Division of the U. S. Signal Corps began to organize the spruce lumbering industry last November, there were only 3,000 men working in the spruce logging camps of Washington and Oregon, and the output for airplane use was wholly inadequate. Nine months later there were 10,000 men fully equipped in those same camps, and the output had been quadrupled. It is safe to say that a similar increase in output can be effected in the same length of time for any kind of structural timber. Then why does the government continue to regard steel as a sina qua non, a "this or nothing," for so many structural purposes?

It seems clear that one of the main reasons is to be found in the fact that most of the structural engineers employed by the government are Eastern engineers who have had little experience with timber work. In addition, they know almost nothing about the timber resources of the West and South. Finally, they are so accustomed to designing with a view to securing the least cost over a term of years that it is difficult for them to realize that they should cast that criterion to the winds. Indeed, they should go farther and subordinate all costs of the structures they are designing to a much more profound cost—the cost to the public in general.

By this last rather vague phrase we mean this: A million tons of steel may cost a hundred million dollars, but if it is taken away from industries that would have used it for needed machinery, cars, motor trucks, etc., the decreased efficiency of the workmen who would have used that machinery, etc., may cost the country several times a hundred million dollars. In short, even supposing that lumber to replace the steel were more expensive than steel—which would rarely be the case—still it would now be economic, from the broad viewpoint, to use lumber instead of steel wherever practicable.

It is hardly to be expected that structural engineers will take this broad economic viewpoint unless they are instructed to do so by some government authority. Unfortunately there appears to be no such authority, no individual or board that is studying the entire problem of providing materials in such a way as to secure the maximum of economy for the country as a whole. It is a great engineering problem, one of exceeding complexity. In the proper solution of it, one should not confine his attention merely to what the maximum output of each kind of material has been, but he should estimate what it can become in a limited time under pressure.

The old saying that "the future can be judged only by the past" is true, but it does not mean that past performance in any individual case is the only standard by which to estimate future performance. Yet, again and again, have those possessed of governmental authority erred through a narrow interpretation of the old formula, "the future can be judged only by the past." Because our lumber output has been a certain amount seems to such thinkers a sufficient reason for limiting the total demand to that output. Whereas any one well acquainted with the lumber industry knows that the output can be readily multiplied several folds if necessary.

We have spoken several times before of the narrowness of view of those in charge of the shipbuilding program. The first of this year only 15 per cent of the 8,600,000 tons of ships contracted for was to consist of wooden vessels. This percentage has been slowly rising, but in the face of no slight opposition on the part of the authorities. Sophistical reasons without number have been used to oppose a program of extensive construction of wooden vessels. First it was argued that timber of the right sort and size could not be produced rapidly enough. Next that the race of ship carpenters was extinct. Then that wooden ships exceeding 3,500 tons could not withstand the storms. Then that vessels made of green lumber would last only two to four years. And so on, ad nauseum.

In the face of all this opposition, and practically without encouragement by the government, Western and Southern structural engineers and contractors, aided by lumber producers, have forced an increasing recognition of the merits of wooden vessels in this war crisis. They have shown that 5,000-ton wooden vessels are practicable, and we doubt not that they will go farther, before the war is over, in designing large wooden ships. They have proved that a new race of ship carpenters could be made to order; moreover, that entirely new tools and devices could be invented for speeding up the building of wooden ships. In short, they have overwhelmed every argument of their opponents, who, sad to say, were often in the employ of the government.

Engineering and Contracting "holds no brief" for the lumber industry, nor for any class of civil engineers or builders. Its chief editor, however, lived several years in the state of Washington and there learned to have a wholesome respect not only for the structural merits of timber but for the abilities of the men who produce it, for the engineers who use it in their designs, and for the contractors who frame and erect it. Lumber is susceptible of countless structural uses, and for many purposes is preferable to steel even in normal times. In abnormal times like the present, the rapidity with which the output of lumber can be increased, and the ease with which men can be trained to frame and erect it, justify the most serious consideration of timber as a substitute for steel.

# Should Criticism of Government Officials Be Held in Abeyance During the War?

Writers on political economy have frequently defended bipartisan government on the ground that the criticism of the minority party tends to restrain the majority from unwise acts. Partisan criticism, in spite of its usual objectionable harshness, has been very useful in the past; but we are now being told that it is wrong to criticise the Government at all during the war, because to do so is tantamount to lending direct aid to the enemy.

From a recent daily newspaper we quote the following:

> Charles M. Schwab, director general of the Emergency Fleet Corporation, speaking before the Associated Advertising Clubs of the World at Berkeley, Cal., paid a deserved tribute to newspapers when he said that "one of the contributing factors in the rapid and successful building of ships was the patriotic comment and criticism of the press."
>
> It is noteworthy that Mr. Schwab used the word "criticism" at a time when certain politicians are so anxious to suppress all criticism.
>
> But there is a difference between Mr. Schwab and some politicians. Mr. Schwab is a builder, an industrial constructionist, with a genius for handling big things in a successful way.
>
> Yet, with all his native ability, Mr. Schwab would not be the successful man he is, throughout his life, had he closed his ears to constructive and helpful criticism and comment.

Criticism of governmental conduct of war affairs has also been objected to on the ground that no critic can have all the facts essential to sound judgment. Moreover, it is urged that some of the brightest and most successful business men and engineers in America are now in actual charge of most important departments of the Government. But this objection is equivalent to affirming that these Government administrators are not only possessed of all the facts but have the power to interpret them correctly in every case. We doubt whether many of our readers will give consent to any such generalization. So able a business man as Schwab, for example, may have an inadequate conception both of the possibilities of lumber production and of the structural uses of timber. As a specialist in steel it is likely that he does not know a great deal, either, about timber resources or uses.

There are many civil engineers who know far more about railway construction and operation than does any railway president who is not also an engineer. Because such a president has risen to his high executive position and a salary of $50,000, should an engineer in a subordinate position at a less salary keep his mouth closed when a railway executive is making a serious mistake?

There is altogether too much reverence for the opinions of successful executives even in their own fields of action. In many cases the main reason for their success is their ability to select and retain able assistants. Carnegie repeatedly gave that as an explanation of his own phenomenal rise to wealth and power. When a successful executive begins to act mainly on his own knowledge, and particularly when that action is in a realm new to him, he is quite prone to err. Indeed his very self-confidence is apt to lead him into error.

A knowledge of all the data of any subject does not reside in the head of one man or of a small group of men, however eminent they may be. Even a very young and inexperienced man may have more complete and accurate knowledge of certain things than the oldest and most experienced expert in that field. Witness Louis Agassiz at the age of 27 telling the geologists of the world that they were all wrong about the origin of most of the drift deposits of northern Europe. From a brief but very careful study of certain Swiss glaciers he had come to the conclusion that many of the drift deposits in Switzerland were of glacial origin, although they were far beyond the limits of existing glaciers. Then he formed his epoch making generalization that a great glacial ice sheet, a mile thick in places, had at one time come down from both poles of the earth for thousands of miles; and that, during this glacial period, vast changes had been wrought in the earth's surface. Then witness the most celebrated geologist of Germany, von Buch, and the most celebrated physical geographer of the world, von Humboldt, gravely advising young Agassiz to stick to his study of fishes and leave to experts in geology the study of geology. For ten years, in spite of accumulating evidence, nearly all geologists rejected Agassiz's explanation of the existence of moraine deposits and glacial boulders. The eminent von Humboldt, a truly great thinker, never did become a convert to Agassiz's revolutionary theory.

The existence of an enemy who may take some consolation from American criticism of American conduct of war affairs should not be made an argument against such criticism. Neither should the eminence of any man in the employ of a democracy free him from fair criticism of his judgment or his conduct, war or no war. Indeed, is not the very existence of war a reason for more searching criticism than in times of peace?

## Are We Not in Danger of Building Too Many Ships?

A 3,500-ton ship in 14 calendar days and a 12,000-ton ship in 30 calendar days, are records of rapid construction never dreamed of before America began building ships on a grand scale. A destroyer, the "Ward," was launched in 17.5 days, and was in commission 71 days after the keel was laid. Formerly it required two years to build and equip a destroyer; so the "Ward" was turned out in one-eighth the time that was considered necessary prior to the war.

Up to the present the launching of the 12,000-ton "Invincible" in 24 working days, or 30 calendar days, is the most remarkable speed record ever made in steel ship construction. The weight of steel in this vessel is approximately 4,000 tons. Hence 170 tons were placed every working day. The construction crew of 1,500 men worked day and night except Sundays and 2 days during a strike. About 40,000 rivets were driven daily on this hull. The "Invincible" was built in the Alameda (Cal.) yards of the Bethlehem Shipbuilding Corp.

In estimating our output of ships during 1919 Hurley has said that our 750 ship ways should each average one ship every 4 months; but it has now been demonstrated that it is practicable to deliver a steel ship a month from each way. Since the ships will average 6,000 tons each, it follows that America could produce 54,000,000 tons of ships in 1919 were every yard to average a ship a month per way. This would be one-fifth more than the entire merchant marine tonnage afloat in the world at the present time.

These estimates, which are based on actual performance, show conclusively how futile is the attempt of the Germans to win the war by submarine attacks. In recent months the submarine sinkings have averaged less than 300,000 tons a month, and the total loss for 1918 will be less than 4,000,000 tons.

The question that now begins to rise is whether we are not in danger of going to a foolish extreme in shipbuilding. When the Germans were sinking vessels at the rate of 8,000,000 tons a year, as they were for a few weeks just prior to America's entry into the war, the allies became somewhat panicy. It was during this panic period that our vast shipbuilding program was made. It was then estimated that in order to be on the safe side, America should produce more than 10,000,000 tons of ships annually and new ship yards were begun to provide such an output. But the unexpected happened in two directions: First, the means of destroying and circumventing submarines were so rapidly and greatly improved that losses from submarine attacks were soon reduced 50 per cent. Second, the estimated output of our ship ways was doubled, and, in many instances, doubled again. The fabricated steel ships proved to be an invention susceptible of much more rapid construction that even its originators had dreamed. Therefore, has the time not come for a restudy of our shipbuilding program, this time in the light of the experience of the last six months and with no panic upon us?

Good engineering involves properly proportioning the various elements of a plant. The war-making plant consists of hundreds of elements, ships being one of these and a very important one. But merely because ships are important forms no justification for building them in great excess of probable requirements. The army badly needs more "tanks" and airplanes; and doubtless there are scores of other elements of this huge war-making plant that are not available in sufficient quantity. From the evidence available it appears that we are in danger of overdoing shipbuilding, and, if so, of underdoing the manufacture of "tanks" and other necessary engines of war.

## War and Science

In a Saturday Evening Post article by Floyd W. Parsons, entitled, "War and Science," we are told that "war today is 75 per cent engineering and 25 per cent military." The author says:

> [illegible]
>
> [illegible] construction and general engineering practice. It is evident, [illegible]
>
> [illegible] not have their eyes turned so earnestly to America. India and [illegible] is organized knowledge, however that will prevail, and the [illegible] the present generation has the numerical superiority in men [illegible]
>
> [illegible] back of the lines in France the need is for thousands of experienced foremen to supervise thousands of gangs. The laboratory and factory worker must give way to the outdoor construction boss.
>
> [illegible] country of recent intense industrial advancement. Her initial [illegible] empire knew exactly what he was to do, and on the first call [illegible]
>
> [illegible] a number double the total of any two other nations. However, [illegible] purely war work.

The rest of the article consists mainly of a record of achievements of American scientists and engineers. For example:

> [illegible]

Aside from the interest that engineers naturally take in all well written accounts of engineering and scientific achievements, such popular articles as this by Mr. Parsons should have a special interest to our readers at the present time. Now, as never before, engineering is being advertised. In the popular magazines and daily papers scarcely an issue appears without some direct or indirect tribute to engineering. Again and again has this war been called an "engineering war." The spectacular achievements of American engineers and contractors have received enormous publicity, starting with the unprecedented rapidity with which the cantonments were built last year, and continuing through an unbroken succession of structural feats without precedent. On the fourth of July we launched more ships than Germany had sunk in the entire month of June, and among our vessels was one of 12,000 tons built in 38 days. A few days later every moving picture theatre in the country was showing the huge "Defiance" gliding down the ways, and a month later followed its sister ship, the "Invincible." Sights like these give great reality and vividness to the printed accounts of these engineering achievements. Even the least educated can appreciate, in some measure, what is being accomplished in the engineering world.

Engineers should see to it that the public, once aroused to the worth of engineering, shall never slumber again.

## The Skip Stop Plan and Peak Load Reduction in Street Car Service

To the Editor: During these busy war times when everything seems to be going up, the street car lines are demanding higher fares in order to pay for increased wages and cost of equipment. Some detailed investigation should be made to relieve the situation without raising the fares.

The skip stop plan is being tried, but does the general public know the actual saving in the operation? Would it not be well to meter a dozen cars and note the amount of current saved and publish a complete report. I am of the opinion that the skip stop plan is equal to an 8 ct. fare and believe the City should make a study and report before any raise should be permitted.

Further, 10 to 15 per cent of the rush hour or peak load could be reduced by the Company offering for sale tickets 6 or 7 for 25 cts., good only during certain hours. There are thousands of women shoppers that would take advantage of a cheaper rate, using the cars during the morning or early afternoon hours and leave the use of the cars for those who work.

On the Elevated roads the skip stop plan would save and many people would rather wait a minute or two than have the fare raised.

Edgar A. Rossiter,
Chicago, Ill. Civil Engineer.

**Piecework at Shipbuilding Plant Increases Output 65 Per Cent.**—An increase in production of 65 per cent is shown since the piecework system was adopted at the Submarine Boat Corporation yard, according to Speed Up, official publication of the company. Records of work in the shops and on the bending floors from Aug. 1 to Aug. 10 show that one gang turned out 139 frames in the first nine working days in August. The highest single day's earnings for the leader of this gang was $19.04; his helper, at the furnace, $17; the remainder of the gang averaged $13 a man. Another gang turned out 87 frames in five days, the highest night's earnings of the leader being $19.19. Another crew turned out 87 frames in nine days, most of the work being upon difficult angles. Still another crew, in seven nights, turned out 65 frames, the leader's highest night's pay being $23.61.

## A Pontoon Drawbridge that Operates on "River Kite" Principle

By HALBERT P. GILLETTE.

After assembling the boats, planks and other materials along the bank, a pontoon bridge can be thrown across a river at the rate of 10 lin. ft. of bridge per minute.. A river 300 ft. wide can thus be bridged in half an hour. This seems almost incredibly rapid, even where the men engaged in building the bridge are "as thick as fleas." But it is feasible to do much better and to throw a 300-ft. pontoon drawbridge across a river in five minutes. What is more remarkable, one man can "throw it" after all the materials are assembled.

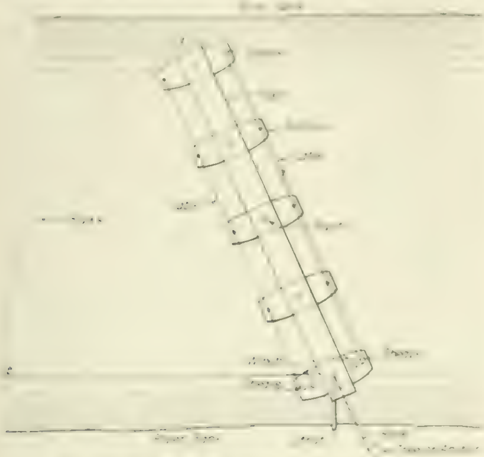
The pontoon drawbridge that I am about to describe operates on the principle of the "river kite," which I described in the Jan. 10, 1917, issue of Engineering and Contracting. In that article I showed how a "rudder boom" is built for the purpose of deflecting shingle bolts or floating logs into a "pocket" at the bank of a river. Rudder booms have long been used in the far west by shingle mill operators. These booms are so designed that one man can swing the boom across the river in a few minutes or withdraw it even more quickly. The force of the river current is made to do all the work of swinging the boom across the river, making the operation appear at first sight like lifting one's self over a fence by one's bootstraps. However, the principle involved is exactly the same as is applied in flying a kite in the air. The current of the river takes the place of the current of the air—the wind. The air-kite moves up and down in a vertical plane, whereas the river-kite moves in a horizontal plane, floating on the river.

**Design of Pontoon Drawbridge.**—My application of this kite principle to a pontoon bridge is shown in the accompanying sketch. Upon a series of pontoons is laid a bridge floor, each pontoon being pivoted at its center to the floor beam above. I have not attempted to show the floor beams and stringers in the sketch, nor the details of the pivoting. A wire cable connects the bows of the pontoons, passes around a sheave on the rear pontoon and onto the drum of a winch. A similar wire cable should be used to connect the sterns of the boats, to provide against breakage of the other cable and to speed up the swinging of the drawbridge where speed is an object. The rear end of the bridge is anchored to a tree or "deadman" on the bank.

First let us assume the bridge to be in the position shown in the sketch, then to swing it back to the shore, all that needs be done is to throw off the dogs on the winches. Thereupon all the pontoons swing on their pivots until they point directly down stream, and the entire bridge swings about the center of the rear boat as an axis, until the forward end of the bridge, A, reaches the position B. A converse movement occurs upon winding up the cables on the winches, so as to throw the A pontoons at an angle with the river current. Then the forward, or downstream end of the bridge at 1B moves in arc across the river to A.

In my article in the Jan. 10, 1917, issue of Engineering and Contracting, I deduced a formula for application to "rudder booms," and I there showed that the most effective angle for the rudders was at 45° with the current. In this pontoon bridge, the pontoons act not only like the rudders in the rudder boom, but like the boom itself; the upstream side of the boat being like the upstream face of the rudder, and the stern of the boat being like the boom. Consequently if the length of the pontoon is great compared with its beam width, the bridge can be made to swing out to an angle with the current that will considerably exceed 45°; whereas rudder booms are seldom designed to swing even to a 45° angle.

**Application to Temporary Bridging and for Pioneer Roads.**—It often happens that a temporary bridge is needed. In such cases the pontoon drawbridge is worth consideration. It is superior to a fixed pontoon bridge wherever floating logs or ice are apt to lodge against the bridge. A pontoon drawbridge can be swung back to allow a log jam or an ice jam to release itself, or it can be kept swung back except at the times that it is needed. It does not interfere with navigation.


Application of Kite Principle to Pontoon Bridge.

A cheap pontoon swingbridge can be made of air-tight barrels, held together to form rafts that serve instead of boats. A still cheaper design for pioneer purposes is one in which cedar or pine logs are used to make the rafts that serve as pontoons.

After a pontoon drawbridge is swung into place, the floor beams over the pontoons should be blocked up, the blocks resting on the pontoons. This may be done in less than a minute.

**Concrete Forms Wet with Hose Gave Smooth Surface Finish.**—In placing the concrete casing on the steel work of the Pelham Parkway Station of the New York City rapid transit lines sludge oil was used at first on the forms. It was found, however, that the oil stained the concrete, so on the later work the oiling was eliminated. As a substitute the forms were wet, previous to pouring the concrete, by playing a hose upon them. This proved an effective method of making the wood forms watertight and resulted in securing a smooth uniform surface finish that reduced the surface rubbing to a minimum.

**79 Ribs for Wood Ships Erected in 30½ Hours.**—Two framing crews, each consisting of 17 men and a foreman, at the plant of the National Shipbuilding Co., Orange, Tex., erected 79 ribs for a Daugherty type of wood ship in 30 hours and [illegible] minutes. Each frame contains 5,000 ft. of timber.

# The Deactivator System for Elimination of Corrosion in Hot Water Supply Pipe

In a paper presented last year before the American Society of Heating and Ventilating Engineers, Mr. F. N. Speller, Metallurgical Engineer, National Tube Co., described a method for the elimination of corrosion in hot water supply pipe. It was shown in this paper that by keeping hot water under pressure in contact with a large surface of iron for a sufficient length of time it was possible to remove and "fix" the oxygen, and thus render the water practically inactive or non-corrosive. The successful adaptation to practical uses of the method was shown by diagrams of two plants that were in actual operation. One of these plants is at the Irene Kaufmann Settlement in Pittsburgh, and the other at the Research Laboratory of the National Tube Co. in McKeesport, Pa. A recent examination shows that no appreciable corrosion has occurred in the pipes carrying the deactivated hot water at these plants. On the other hand, there has been a great deal of trouble connected with other pipes in the same buildings which carry hot water not treated by the deactivator system. The sheet iron with which the heating tanks are packed has not yet given out and is apparently as active as ever after 2 years' service.

In a paper presented at the last annual meeting of the above society Mr. Speller and Mr. R. G. Knowland of the Department of Applied Chemistry of Massachusetts Institute of Technology give a further discussion of the method. An abstract of this paper follows:

Because of the manifest advantages of this method of preserving the hot water piping in apartments and similar situations, it was decided to install a plant larger in capacity than those in Pittsburgh and McKeesport. The apartments at Hemenway Terrace, Boston, Mass., were selected as affording typical conditions; and the installation was made by the Research Laboratory of Applied Chemistry of the Massachusetts Institute of Technology acting in co-operation with the Research Department of the National Tube Co.

**Deactivating Plant at Hemenway Terrace, Boston.**—The hot water supply at Hemenway Terrace is furnished by two heating and circulating systems, each complete in itself and separate from the other. The amount of water heated is about the same for each system and reaches a week-day maximum of about 650 gal. an hour. The deactivator, which went into operation on March 15, 1917, was placed on one of the supply systems, thus leaving the other free for purposes of comparison. It consisted of a Gurney coal-fired heater, a treating and storage tank, and a filter as shown by Fig. 1. The tank was built with a 42-in. flanged head, thus permitting easy packing of the Cambridge metal lath with which the tank was filled in horizontal layers from bottom to top. In circulation, as the arrows indicate, the water passes from the heater up into the deactivating tank where it makes contact with the sheet metal at a high temperature. It moves through this slowly as cooling currents or water from the cold supply urge it, and back into the heater or off through the house supply line.

The hot water house supply pipe leaves the tank at the top and passes to the filter, part of its contents being shunted off through a coil in the filter bed. A constant circulation of hot water in this coil makes it impossible for the filter to reach a temperature notably lower than that in the deactivating tank itself. Through a four-way valve at the top of the filter, the water for circulation in the house system passes into the space above the filter bed and down through the sand into a chamber at the bottom. In this passage, the rust formed in the deactivation of the water is wholly removed. The house supply is withdrawn through the vertical pipe in the center of the filter, while the gravity return line entering at the bottom provides for a continuous circulation of water. It is thus apparent that there are three complete and independent systems of circulation: (1) the one between the heater and tank; (2) that between the filter and tank for keeping the former hot, and (3) the house and filter system.

**Operating Results from Plant.**—The success of the apparatus in removing the dissolved oxygen from the heated water is shown in Table I. That this removal of oxygen is accompanied by highly beneficial results will be understood from a comparison of present and past conditions at the apartments. When the deactivator was placed in operation, each hot water system had been in service for about 11 years. The one which we are particularly considering had been the source of great trouble and complaint and pipes were giving way very frequently. It had also been necessary to place three plugs in the supply tank where corrosion had caused the formation of large pits which broke through the metal. Everything in fact pointed toward the rapid destruction of the system. When the deactivator was installed, these sources of annoyance immediately ceased; and since that date no replacements have been necessary. On the other hand, the system which was not equipped with a deactivator went completely to pieces in a few weeks' time. Fifteen holes in the tank were plugged, and finally it became necessary to replace this bodily, the destruction of pipe in that system containing as before.

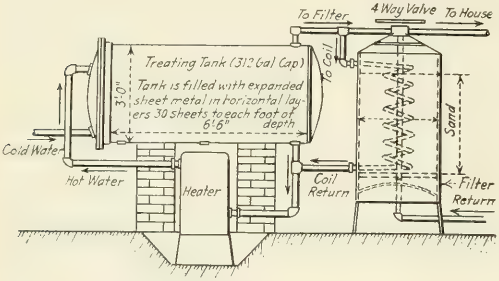

To Filter
4 Way Valve
To House
Treating Tank (312 Gal Cap)
Tank is filled with expanded sheet metal in horizontal layers 30 sheets to each foot of depth
3'-0"
6'-6"
To Coil
Sand
Cold Water
Hot Water
Heater
Coil Return
Filter Return

Fig. 1—Water Heater and Deactivator for Apartment House in Boston.

In removing contiguous piping for installing the apparatus, it was found that it was almost completely filled with rust and dirt of various kinds. The superintendent of the building, after four months' use of the deactivator, reported that the pressure throughout the house has doubled. That this is due to the cleansing effect of the water is certain, since for two months after the apparatus was put into operation the hot water showed a distinct coloration.

Table II has been inserted to afford an idea as to how corrosion in a hot water supply system apportions itself between the tank and the pipe-lines. This table is based upon data obtained from the system that is not provided with a deactivating tank. The difference between the dissolved oxygen content in the cold water and that in the hot water (analyses taken at the tank) will indicate the amount of corrosion within the supply tank as compared with that which occurs in the lines when the hot water is passing through them. The fact that several times as much metal is rusted away in the tank as in the piping would be predicted from the higher temperature of the former and the fact that the hot water is in contact with the tank for a considerable time before being drawn into the piping system.

From the standpoint of economy, the use of the deactivating system is recommended by its results. It is much cheaper and vastly more convenient to corrode away 100 lb. of sheet metal in the basement than the same weight of piping in miscellaneous locations throughout the house. The question as to how long the sheet metal will last can no more be answered than one as to the life of a hot water system before it has been tried out. However, it has not been necessary to replace the sheets in two years' operation of one of these plants. Furthermore, such a question is relatively unimportant, since the economy of using the sheet metal does not depend upon its cost. The real advantage of the deactivator lies, as we have suggested, in the fact that, without regard to its own cost, a material is wasted that is always somewhat cheaper than pipe; and that the danger, annoyance, and expense of replacing corroded piping is largely circumvented. The latter are very real problems as all real estate owners are well aware. Their elimination would do much to relieve one of the serious causes of complaint by tenants in apartment houses and hotels.

TABLE I. RESULTS IN REMOVAL OF DISSOLVED OXYGEN.

| Month. | Temp. in deg. Fahr. (Average). | Oxygen in cc per liter. Cold. | Hot. |
|---|---|---|---|
| March | 163 | 8.29 | 0.11 |
| April | 174 | 8.12 | 0.05 |
| May | 175 | 6.97 | 0.07 |
| June | 176 | 5.66 | 0.00 |
| July | 185 | 4.56 | 0.00 |
| August | 163 | 3.91 | 0.00 |
| September | 148 | 4.33 | 0.00 |
| October | 182 | 4.87 | 0.45* |
| November | 155 | 6.16 | 0.26* |

*This value is not an average for the month, but was taken at a time of severest demand, when the requirements probably amounted to 1,200 gal. per hour. The system was designed for a maximum of 65 gal. per hour.

In summer there is less dissolved oxygen in water than in winter, the phenomenon being due to the lower solubility of gases in water at the higher temperatures.

TABLE II.—AMOUNTS OF DISSOLVED OXYGEN DETECTED IN SYSTEM NOT EQUIPPED WITH DEACTIVATING TANK.

| Month. | Temp. in deg. Fahr. (Average). | Oxygen in cc per liter. Cold. | Hot. |
|---|---|---|---|
| March | 176 | 8.29 | 2.26 |
| April | 158 | 8.12 | 1.58 |
| May | 141 | 6.97 | 1.69 |
| June | 144 | 5.66 | 2.01 |
| July | 144 | 4.56 | 2.32 |
| August | 148 | 3.91 | 1.45 |
| September | 138 | 4.33 | 1.53 |
| October | 120 | 4.87 | 3.76 |
| November | 138 | 6.16 | 3.02 |

The average of 65 analyses on the deactivating system shows that a final oxygen content of 0.06 cc per liter is to be expected in the deactivated water, starting with an initial content of 6.41 cc per liter.

The same number of analyses on the non-deactivating system shows a final oxygen content of 1.74 cc per liter with an initial content of 6.41 cc per liter.

The theoretical increase in life of tank and piping, therefore, when equipped with a deactivator will be 1.74 / 0.06 = 29 fold. This theoretical increase is affected by the fact that corrosion is not always uniform, but is usually accompanied by pitting, which is the actual destroyer of the tank and piping. It goes without saying, however, that the deactivator will increase the life of a hot water supply system many times. Conservative estimates would make the increased usefulness of the apparatus lie between five and fifteen fold, depending upon local conditions of the installation. Such an estimate obviously holds only for plants designed in the proper proportions based mainly upon the character, maximum hourly consumption, and the temperature of the water.

**General Application.**—The effectiveness of this method of oxygen removal is obviously not limited to installations of steel or of wrought iron pipe, although practical considerations of cost would suggest its use in systems over a certain size in combination with steel pipe as forming the most economical layout. As considerations already discussed would indicate, the life of brass or of bronze pipe may likewise be greatly increased by the removal of dissolved oxygen from the water. While it is true that under the usual conditions of service brass is comparatively durable, it is very often subjected to severe corrosion which is not apparent until failure occurs. With galvanized iron, on the other hand, the first evidence of rusting is found in the appearance of discolored water long before the pipes are seriously damaged. There are many localities where the water is alkaline and hard to such a degree as to prevent serious corrosion even in the hot water lines. In the large majority of cases, however, it would appear that the protection of a hot water supply system by deactivation of the water should be undertaken as a matter of common precaution.

## Pneumatic Machine Bends Cold Plates in Compound Curves

A new cold plate bending machine that executes compound curves, is now in successful operation at the yard of the Pensacola Shipbuilding Co., Pensacola, Fla. The machine, which was perfected by S. J. Robinson, Chief Engineer of the company, was designed to do the work ordinarily done by the pyramid type of plate bending rolls.

The frame is made of 15-in. I-beams, carried on a concrete foundation. Between the beams are 14 pneumatic hoists, with 12-in. diameter pistons and 7-ft. stroke. On the top flanges of the I-beams are bolted structural steel formers with curvatures corresponding to the bends desired in the plate. The plate is placed vertically against the formers, and the bottom clamped in place against a structural steel bracket. On the head of each piston rod is a chain sheave, and around this sheave is a length of $^{7}/_{8}$-in. coil chain. Each end of this chain is passed over a sheave carried on the outer end of the I-beam base, and a saddle casting which is laid on the edge of the plate. The ends are hooked to the base, and the application of compressed air to the cylinders pulls the plate to the formers. The rear ends of the cylinders are piped for water instead of compressed air, and the length of stroke and speed of travel are governed by allowing the water to flow out through a controlling valve. An especially valuable feature of the apparatus is its ability to bend warped surfaces at one operation, as the radius of the formers at any point determines the curvature at that point.

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**Rope Mat Facilitates Driving of Precast Concrete Piles.**—By using a rope cushion on precast concrete piles better penetration was secured and damage to piles and hammer eliminated. The cushion consisted of old 2-in. Manila rope coiled into a circle large enough to fit the head of the pile. Each mat could be used but once. The piles were 12x12 in., 30 ft. long, reinforced with a $^{3}/_{4}$-in. rod at each corner. They were driven with a No. 1 Vulcan hammer.

# Safety Engineering and Accident Prevention in Construction Work*

By LEO P. WOEDTKE

[illegible]

The firm's executive of course, cannot direct the work of accident prevention and safety engineering, and he is not expected to; but he can, and necessarily must, give someone in his employ, the authority and position of Director of Safety or Manager of Accident Prevention Department, or some formal dignified title, and he must necessarily make allowances for reasonable expenditures in carrying out this work.

Letters and instructions to all superintendents, foremen, straw bosses, purchasing agents, department heads, field offices and jobs, must of course be written, and should be signed by the firm's executive to establish the authority, and secure the respect and co-operation due the man who is to carry out his work, for without such a start he can never hope to succeed.

**How Safety Director Can Obtain Information for His Work.**—Once established, the Safety Director should study the particular line or lines of construction work his firm is engaged in and fortify himself with all available information, data, bulletins, instructions, safety guards, etc., applicable to the types and kinds of operations engaged in by his firm.

There is a fund of such data and information at the disposal of any one who is seriously interested.

The National Safety Council has hundreds of especially fine illustrated bulletins, designed especially for construction work which should be posted on the job bulletin boards. They also have issued several splendid "Safe Practices" pamphlets on goggles, engine guarding, engine stops, freight elevators, grinding wheels, couplings, pulleys, gears, scaffolds, etc., and also have a splendid library equipped with three libraries. They now also have a specialist in Safety Engineering and Accident Prevention on Construction Work, Mr. Sidney J. Williams, manager of their Accident Prevention Division, who has spent several years in and about general construction work.

Also, most all large insurance companies now maintain an efficient accident prevention department, and issue many valuable bulletins and furnish safety inspections, advice, co-operation, etc., without cost to their policy holders.

Then also, there are a number of publications devoted entirely to safety work, as for instance "Safety Engineering," issued monthly at a small subscription price. You can also secure without cost simply by application "The Monthly Review of the United States Bureau of Labor Statistics" by writing to Mr. Royal Meeker, Commissioner of the Bureau, at Washington. Then also there are many local safety council branches of the National Safety Council throughout the country, and they should be joined if one is in the locality or near by, to get the benefit of their round table meetings, mutual experiences, etc.

The matter of mechanical safeguarding wherever possible is most important and a complete list of manufacturers of safety devices and appliances of all kinds can readily be secured from the National Safety Council.

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*[illegible]

**Securing Co-Operation of Foremen, Superintendents and Straw Bosses.**—Construction superintendents, foremen and straw bosses are of course pushing a job continually to get it done in the shortest possible time and at the least possible expense, and must be approached on safety work and accident prevention with clear and reasonable requests.

They must be educated to the safety idea gradually and in a systematic and consistent manner without the use of sarcasm or destructive criticism.

Write them a personal circular letter at least twice a month and always enclose with it from two to four new bulletins for each of their bulletin boards. Continually call their attention to types and causes of accidents prevalent on their job or on other jobs, always stating a remedy or a preventive suggestion and inviting their ideas and suggestions to eliminate or reduce the causes of accidents.

Do not hesitate to call their attention to accidents which have occurred on their jobs or certain types and causes of accidents which are running the highest or which have increased in number, but also give them credit and a little praise when they are showing good results or pulling down the number of accidents on their job.

These men, so keen and able in all their work, are intensely human and accept constructive criticism as well as expect due credit, just the same as you and I.

Unless you eventually succeed in getting the superintendents, foremen and straw bosses, and finally the rank and file of the men on the job to co-operate with you because they "want to" and not because they "have to," you will have failed, and another Safety Director will be needed in a hurry.

**Records of Accidents Kept by Months.**—The Safety Director should keep records of the accidents and statistics for each job separately by months, in order to know while the job is in progress, whether there is an increase or a decrease in the number of accidents, and also that he may keep the job superintendents and foremen advised monthly, for, remember, "The water which has gone over the dam is lost" and there is very little satisfaction in advising a job superintendent or foreman at the finish of a job that he had a bad record. You would not wait until a job was all finished to advise a superintendent or foreman that the job lost money or cost more than it should for any unit or for the whole job, but you would know at least monthly, and possibly weekly, exactly how the cost of the job was running.

**Classification of Lost Time Accidents.**—After considerable experimenting, I have found it advisable to classify only lost time accidents into twelve main causes as follows:

1. Handling materials.
2. Handling tools.
3. Bad or broken tools.
4. Falling or flying objects.
5. Poor or broken staging, scaffolds and runways.
6. Lack of toe boards, rails, screens.
7. Falls or slipping.
8. Protruding nails.
9. Ladders.
10. Ropes, chains, cables.
11. Machinery and equipment.
12. Miscellaneous.

And to bunch all no lost time accidents under one group. Also to split the lost time accidents into compensable and non-compensable groups, as well as to record the number of disabilities and fatalities separately.

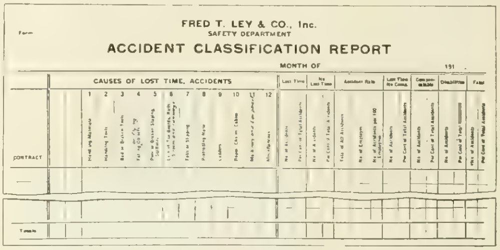
This is easily done by giving each cause a number from 1 to 12 (quote Accident Classification Report) and marking on each accident report received the cause, number and also whether or not the accident is a "lost time" case, whether compensable or not, and also noting if a disability or fatality is involved.

From then on, a clerk can compile this data monthly onto a printed form similar to the one I have quoted and from which you will note it is a simple matter to see at a glance how the accident frequency is running on any job, from month to month, both by causes and as a whole.

**Methods of Keeping Foremen, Superintendents and Workmen Interested.**—There are a number of sound ideas I have used to keep superintendents, foremen and the rank and file on the job continually interested in safety work and accident prevention, some of which I will mention.

Frequent safety letters with information, suggestions, and friendly cricism.

Fresh bulletins for the job bulletin boards at least twice a month. These can be secured from the National Safety Council in any quantity desired. Also many insurance companies furnish occasional bulletins for their policy holders. We have also used several home-made bulletins showing reproductions from photographs of good and bad actual conditions on our own jobs, such as stagings, hammering tools, equipment, elevators, debris, etc., and have also made up blue printed bulletins occasionally by way of novelty and attraction.



FRED T. LEY & CO., Inc.
SAFETY DEPARTMENT
ACCIDENT CLASSIFICATION REPORT
MONTH OF 191 .

Form
CAUSES OF LOST TIME, ACCIDENTS
1
2
3
4
5
6
7
8
9
10
11
12
CONTRACT
Totals

Form Used for Accident Classification Report.

Occasional special articles on some one thing at a time, such as "Chains, Ropes and Cables, Safe Loads, Fatigue, Spreads, Slings," etc., "The Dropsy or Butterfinger Habit," "Fire Prevention," "Am I My Brother's Keeper?" etc.

Patriotic references with regard to "industrial soldiers," "backing up the boys," "standing by Uncle Sam," etc.

Once in a great while a prize bulletin contest, open only to all employes of the firm, excluding executives and the Safety Department, offering small money prizes for the best suggestions for a safety bulletin illustrating a common hazard applying to the firm's operations or to general contracting.

Snappy safety slogans at the foot of all letters of any kind between the office and the job. (The National Safety Council issues a pamphlet listing hundreds of these slogans, and you can create many timely ones of your own.)

Safety slogans, cautions and instructions on the backs of pay envelopes.

Danger tags with the firm's name thereon supplied in small tin half-containers fastened to the inside of tool boxes in the blacksmith shop, tool house, field office, etc., which are available for use on defective or condemned tools, machinery and equipment.

Accident stitistics, both your own actual experiences on any job or on all your jobs as a whole, and also striking general accident statistics which are published from time to time and some of which you heard me quote earlier.

An occasional circular letter signed by the firm's executive asking for a report of what is being done in the way of safety work and accident prevention, the condition of bulletin boards, goggles, tools, equipment, first aid cabinets, etc.

Safety Calendars in cartoons, for use in field offices, tool houses, etc., which the National Safety Council issues at a very low cost each year. (You can have your firm's name printed on these calendars.)

. Some firms also furnish the service of the Life Extension Institute at their expense to regular employes, including physical examination and personal reports. "Keep Well" leaflets, the Institute's monthly publication "How to Live," etc. Undoubtedly the sound and healthy employe meets with far less accidents as he is usually satisfied, efficient and contented. This service, of course, cannot be given to the floater or temporary employe.

It is also well to encourage and invite suggestions, ideas and constructive criticism, from any and all employes, as many splendid results and often good data or methods are thus secured.

Competition can also be created by quoting the records of various jobs on a percentage basis of accidents per hundred men and is a good occasional stimulant.

When a new critical departure or strict rule is necessary, it is often well to have a firm executive sign the circular letter used covering it.

A small pamphlet of safety instructions and rules can be drawn up and printed, to be given every new employe when he is hired, and also a different pamphlet on similar lines for the superintendents and foremen. These pamphlets might be called No. 1, and additional new or corrected pamphlets issued from time to time in the future, numbering them in order.

The compilation of a chart showing the accidents two or three years ago as a base and reduction or increase by yearly quarters thereafter, creates keen interest when blue printed, distributed, and posted on the various jobs occasionally. Creating the first chart is of course the most difficult and the statistician or safety department of your insurance company will usually work it out for you or with you, after which time it is not difficult to add the results from quarter to quarter. Such a chart, as for instance in my own case, is very instructive and interesting as it shows a fluctuating increase over a spread of three years from 13 to 80 persons, sometimes dropping down, but usually gaining (quote chart). The first quarter of this year recently computed shows the percentage of reduction as 79 per cent. The computation of the second quarter is not quite completed on account of the season being rush and at the peak of the construction industry.

There are any number of ideas which can be worked out to secure and keep up the job's interest in safety work which develop as you go along.

There is a big psychology about the "safety bug" in that the deeper you get into it, the deeper you want to go.

### Accident Prevention Methods Employed by Fred T. Ley & Co.

**Handling Materials.**—Wheelbarrows, canthooks, ropes, chains, and slings, blocks and falls, scale boxes, dump and flat cars, derricks, cranes, etc., kept in good condition or discarded if unsafe. Constant inspection made and employes requested to report all unsafe conditions and the use of danger tags and faulty or condemned equipment.

Stout, sound runways, platforms and stagings of selected materials and safe construction. Close supervision by foremen is required in this connection.

Proper piling and placing of piles of lumber, brick, pipe, cement, stone, tile, etc.

Continual cautioning by foremen against "fooling," the "dropsy habit," "butterfingers" and overloads.

**Handling Tools.**—Heads of poor points, chisels, drills and hammering tools dressed and trimmed every time points or edges are sharpened. Also care in over or under-hardening.

All handles well wedged and supply of new handles on hand.

All tools stored in modern racks in tool houses with heads, faces, etc., exposed to show condition and need of attention.

Danger tags in tin half-containers, conveniently placed in tool boxes, tool houses, field offices, etc.

Foremen, blacksmiths, and tool men made responsible for inspection, repair and up-keep of all tools.

Constant instruction and education against careless sawing, hammering, use of wrenches, etc., causing injuries to hands and limbs.

**Bad or Broken Tools.**—Every accident from such cause should be closely investigated, bad tools to be especially called to the superintendent's and foreman's attention, and poor tools being called to the purchasing agent's attention.

There are many safety types of tools, references to which can be secured from the National Safety Council, and such data should be furnished the purchasing agent.

Tools showing inferior quality or defective material should be taken up with the manufacturer or dealer from whom they were purchased.

**Falling or Flying Objects.**—Suitable goggles provided on every job, in every tool box and tool house. It is well to look over carefully the many types of goggles on the market and secure the advice and consultation of superintendents and foremen before buying in large quantities.

Superintendents and foremen must be held responsible for men wearing goggles when chipping or drilling concrete, stone, iron, steel, etc. Education, preventives and sometimes force must be advanced to the rank and file on the matter of goggles by the foreman.

Extra sets of chipping or drilling tools should be provided on all jobs to allow other sets being repaired or sharpened and not delay or hold up any work.

Toe or skirt boards, screens, etc., on scaffolds, stagings and inclining runways, where materials are stored temporarily, prevent any men below being hit by falling objects.

Chutes for rubbish or waste disposal should be closed in all the way and well guarded on the ground.

**Poor or Broken Stagings, Scaffolds, and Bumpways.**—Sound material of adequate strength, well selected and constructed, without weak knots, also no loose boards.

Band rails or ropes, also screens, in addition to toe and skirtboards on all exposed edges of s'aging, scaffolds, runways, floors and elevator shafts, openings, etc.

Diagram made out by foremen directly in charge of work on which scaffolding, stagings, runways, etc., broke or caused accidents should be secured and the causes "ascertained" so that all other jobs may be advised accordingly.

**Lack of Toe Boards, Rails and Screens.**—As this heading has so much in common with poor or broken stagings, scaffolds and runways, see recommendations made under that head.

Impress on superintendents, foremen and men the injustice of them usually injuring others than themselves through lack of foresight and care in this regard.

**Falls or Slipping.**—Passageways, floors and driveways, and working spaces should be always kept clear of waste or surplus material.

Gates and railings at elevator and hoist shafts, floor openings, etc., should be located at least 18 in. away from openings to prevent persons leaning, being struck, or slipping through the opening.

Fooling on stairways, ladders, scaffolds and stagings should be cause for serious reprimand and discharge if necessary.

**Protruding Nails.**—Waste and debris should be kept cleaned up properly and disposed of through rubbish chutes or piled out of the way.

Kegs and cases when opened should have protruding nails withdrawn or bent over.

Stripped forms in concrete work should be piled clear of passageways as taken down and protruding nails piled downward until attention can be given them.

Every man on the job from superintendent to water boy, should constantly turn over or pick up loose boards or planks with protruding nails. Water boys tool men, etc., can be equipped with hammers on a belt and constantly bend over or pull out protruding nails lying about the job.

Under no circumstances allow an injury from nails to go unattended and make the superintendent and foreman responsible for attendance by a doctor immediately and advocate the doctor using anti-tetanus serum if at all doubtful, as lockjaw cases are almost hopeless in advanced stages.

**Ladders.**—Do not allow ladders to be painted with pigment or lead paint. Insist on new ladders being treated with linseed oil and shellac so that defects or deterioration will always be visible.

Discourage continually the use of home-made ladders and occasionally call for a report from every job as to the condition of all ladders.

Co-operation with the Purchasing Agent towards securing the best possible materials in ladders and even safety types for certain kinds of work where advisable.

If safety feet are used, be sure the type purchased is suitable for universal conditions, such as concrete, wet wooden floors, steel surfaces, etc., as well as for use on the grond. This is a difficult problem and the superintendent and foreman should be consulted carefully on same.

Ladders should be well toed, braced or lashed to prevent slipping wherever advisable, and the safe angles of placing ladders should be complied with. The National Safety Council has recently issued a bulletin showing safe angles for ladders of various lengths.

**Ropes, Chains and Cables.**—Up to date tables of safe loads at various angles of slings for ropes, chains and cables, should be furnished all superintendents and foremen and posted on bulletin boards. The tables shown in old style engineering handbooks are now pronounced inadequate by safety engineers on account of present day materials used in manufacture.

Coils or ropes should never be stored near the acid carboys, the fumes of which disintegrate the fibre without same being visible.

Purchasing Agents should be furnished with up to date specifications on which to buy hand-made or machine-made chains. The National Safety Council will furnish these specifications on request.

Caution superintendents, foremen and men "to stand from under the load," "avoid kinks, twists and sudden jerks," "keep loads off point of hooks," "keep cables well lubricated, and store away from alkalies, gases, fumes, and acids."

**Machinery and Equipment.**—Daily inspection by foremen, riggers, or some responsible person of all hoisting apparatus and mechanical equipment on the job and thorough overhauling at main equipment plant on return from a job.

If equipment is sent from one job to another thorough overhauling or repairing should be made, or if same is not practical all defects or attention needed should be marked with tags and a memorandum or letter forwarded to the job where such equipment is being sent.

All gearings, keys, set screens, exposed shafting ends, revolving projections, etc., should be thoroughly enclosed or well guarded on hoisting engines, drums, winches, mixers, screens, steam shovels, saws, mechanical clutches, grinding wheels, etc.

Safety collars and couplings, headless set screws, shaft pulleys and clutch housing, etc., wherever practicable, adequate grab handles and steps on large equipment, such as locomotives, steam shovels, cabs, cranes, dump and flat cars, etc.

Correct guards on gage-glasses and water columns. This is a serious problem as many types of gage glass guards are not practicable because they require additional holes in boilers, some of which already have too many holes, considerable expense and also loss of time while same are being installed. Types of gage glass guards are now on the market which can be slipped on instantly, and do not require any drilling of boilers, loss of time, and disuse of equipment and master-mechanics, engineers, etc., take more kindly to these types.

Cylindrical or safety heads provided on jointers or buzz-planers, approved safeguards, such as spreaders, blade enclosures, travel limits, table guards, pushers, etc., on all saws. (Circular, spread, cross-cut, overhead, treadle, swing, band, etc.).

Hooks for large hoists, cranes, derricks, etc., provided with handles on the back and where advisable with guards over points of hooks. It is well to consult with the master mechanic and especially the rigger and hoisting men on this matter.

Pulley blocks, whether wood or iron, should be equipped with adequate side plates or flanges to protect mesh points between ropes and blocks. Bearings, pins and wheels should be inspected carefully periodically, as this equipment gets much abuse and wear.

Advocate thorough inspection of all mechanical equipment on rainy days when it is likely some superintendent, foreman, mechanic or rigger may be idle.

Small equipment might just as well be purchased with the safety idea such as safety types of gasoline cans, carboy inclinators, hammering tools, drills, bull points and chisels of the best steel well tempered, etc.

**Miscellaneous.**—Adequate shoring and excavating, or tops kept broken down to prevent cave ins.

Appropriate danger signs, tags, and warnings. On account of men working above or below, dangerous passes, forbidding riding on elevators, public warned to keep out, fire prevention notices, occasional patriotic bulletins assisting the Government in Americanization, Liberty Loans, Thrift Stamps, venereal diseases, etc.

First class guards protecting exposed electric switches, wires, transformers, etc., against personal contact by use of cabinets, enclosures, warning signs, etc.

Children and the public being kept away from construction work where they have no business.

Fire prevention methods, boilers safely housed, spark guards on smokestacks, spark screens on salamanders, fire extinguishers in job offices, tool houses and appropriate parts of the work. The National Fire Underwriters' Association have bulletins you can secure fire prevention.

It is surprising the number of men disabled from work through causes other than accidents. Sunburn, poison ivy, bad drinking water causing dysentery, infection of boils, pimples, etc., and personal advice and caution by superintendents and foremen can reduce this cause of loss of time in many instances.

## Building Interests Select Washington Representative

The National Federation of Building Industries has arranged with Mr. W. A. King of Washington to act as resident representative of the Federation for the next two months. Mr. King is very well known in building circles, being connected with the National Association of Builders' Exchanges as their general consul, and in his law practice he is recognized an authority on many special features relating to building construction work in general. Mr. King has entered upon the task of his duties and already has on his hands several important matters, the outcome of which will develop from time to time.

**The $1,000,000,000 Construction Program of War Department.**—To provide for the needs of the Army the construction division of the War Department has undertaken since April, 1917, a total of 323 operations, and now has in prospect 153 more. The total cost of this program is estimated to be $1,083,766,198. To the end of August, 93 operations had been completed, including the camps and cantonments. The cost of the finished operations was $277,745,847. Additions and alterations of minor character are not figured as "jobs." There are now under construction 266 jobs, which will represent a cost approximating $636,858,351. Practically all of the work now under construction will be finished by Jan. 1, 1919. However, some of the larger jobs, which are of a permanent nature, will not be completed until October, 1919. Included in the present construction are the development of eight port terminals at a cost of approximately $150,000,000. One of these, the Brooklyn Army supply base, estimated to cost $40,000,000, will have the largest warehouses in the world. The other terminals in the course of construction are: South Boston, Mass., which is estimated to cost $28,000,000; New Orleans, La., $10,000,000; Charleston, S. C., $25,000,000; Norfolk, Va., $20,000,000; Philadelphia, Pa., $15,000,000; Newark, N. J., $10,000,000; Newport News, Va., about $5,000,000

## Construction Features of Concrete Ships

In a paper presented at the last annual meeting of the American Concrete Institute, Rudolph J. Wig and S. C. Hollister, respectively Chief Engineer and Engineer of Design of the Concrete Ship Department of the Emergency Fleet Corporation, outlined the progress made by their department in its studies of the problems of concrete ship construction. An abstract of the paper follows:

**The Concrete.**—The concrete must be durable and impermeable to water; it must have a compressive strength of at least 4,000 lb. per square inch at 28 days, and a minimum weight. To meet these conditions we have determined upon the use of a rich mortar mixture. Any standard portland cement which will meet the specifications of the United States Government may be used, provided the fineness is increased so that at least 90 per cent will pass a No. 200 sieve. For the present the maximum-size aggregate is limited to ½ in. A sand and gravel or a volcanic ash or specially burned clay may be used.

The commercial future of the concrete ships is in large measure dependent upon obtaining a light-weight concrete. The strength and weight of one of these mixtures which meets our requirements is as follows: 1 part cement, to 1 part special fused clay below ¼-in. size to 2 parts same aggregate between ¼ and ½-in. size, had a compressive strength of 3,380 lb. per square inch at 7 days and 4,350 lb. per square inch at 28 days. It weighed 106 lb. per cubic foot in a saturated condition. With the use of this material the ratio of the dead-weight to total displacement will be 62 per cent for the 3,500-ton ship as compared with 65 to 68 per cent for a steel ship and 53 per cent for a wood ship. No integral waterproofing compounds of any kind will be used in the mixtures.

**Reinforcing Steel.**—Reinforcing steel which we are using, other than fabric, is of rods or bars rolled from new billets to conform to the American Society for Testing Materials standard specifications for structural grade new billet steel. Plain round bars will be much easier to fabricate than deformed bars, but on account of the uncertainty of the effect of reversal of stress we are using deformed bars wherever the bond stress is high. The accurate bending of the reinforcing is one of the most difficult of all the construction problems. With a wall thickness of only 3½ to 4 in., and two to three layers of steel, need for accurate bending of the steel can be readily appreciated. Furthermore, the curvature is constantly changing forward and aft in the vessel, which requires constant change in the location of the dogs on the bending table. The use of small steel is recommended, in that it is easier to spring into place if the bending is not accurately [illegible]

With a very large quantity of steel, approximately equivalent to 10 per cent of the carrying capacity of the ship, to be placed in a very small space in thin walls, there is much opportunity for the develment of ingenious methods of fabricating the steel. Undoubtedly, much time can be saved by prefabricating or bent in part the steel of the frames and placing them in the ship as units. These frames may be as much as 54 ft. in width and 35 ft. in height, and they must be accurate to within a fraction of an inch. Through a length of 60 per cent of the ship the shape of these frames is constantly changing. All the steel must be supported and secured so that it will not touch the form surface. Numerous methods have been suggested, and there are a number of chairs now on the market for supporting steel, but all of them have objectionable features.

A study has been made of welding methods and machines as a means of avoiding the lapping of the steel. The acetylene weld is rather uncertain and not satisfactory. The electric resistance weld appears to be the most promising and several machines of this type have been ordered and are now being tried out. It is not anticipated that welding any steel other than the main steel of the frames and possibly the main longitudinal steel will be required.

**Mixing and Placing Concrete.**—Rich mortar mixtures will be used, and they must be carefully proportioned and mixed in order to insure the quality of concrete necessary. Special attention should be given to the selection of the mixer, as all mixers of common types will not thoroughly mix mortars. The concrete should not be transported from the mixer and deposited directly into the forms in continuous operation or in large batches, on account of the danger of not having it thoroughly worked into place about the reinforcing steel. For the present it is required that all concrete shall be shoveled into the forms in order to insure its deposit in small batches and its thorough working into place.

It is preferable to place the concrete as one continuous operation in order to avoid construction joints. This will require approximately three days (of 24 hours each) for a 3,500-ton ship and six days for a 7,500-ton ship. No trouble is anticipated in working the concrete thoroughly around and through the reinforcing. The rich mortar mixture proposed is quite fluid, even though it is not mixed to a wet consistency, and with a slight tapping of the forms it settles readily into place about the steel. A number of test panels have been made, and the results in all cases have been entirely satisfactory. It is very different to make a construction joint in a section in which is embedded a large quantity of steel. Most leakage troubles occur at construction joints. The uncertainty of the bond obtained at construction joints is also objectionable on account of the large shear stresses. Several mechanical methods of placing mortar and concrete have received consideration, but the results of investigations do not up to the present warrant their use.

**Durability of a Concrete Ship?**—If durability is to be obtained, special attention must be given to many elements of the ship. The most serious problem is to provide means of adequately protecting the steel from corrosion. There is a large quantity of steel embedded in the concrete and much of it cannot be covered by more than 5/8 in. of mortar. This of itself will not protect the concrete, particularly in the interior and in the upper portions of the hull. There are two means of allaying, if not wholly preventing, the corrosion of the steel. The steel may be galvanized or painted with some protecting medium which will not appreciably affect the bond, or the concrete may be coated with some thoroughly impervious membrane which will prevent both air and water from reaching the steel. A large number of tests are being made, and it is quite possible both methods of protection will be tried. The results are promising and a satisfactory protection should be developed.

Another possibly disintegrating element which may have great importance is the effect of constant reversal of stress, as the ship alternately is subjected to hogging and sagging stresses in a heavy sea. Our allowable steel stresses are such as to cause the concrete to crack. No trouble from chemical disintegration is anticipated except as the hull may be seriously abraded. Sugar and certain vegetable oils, such as the cocoanut and peanut oil, will disintegrate the concrete if it is exposed for an appreciable length of time. If the ships are to be used in this class of trade, a protective paint coating should be applied to the inner surface of the hull.

The Concrete Ship Department estimates the life of the concrete ship without any special protection at several years, and known methods which can now be applied should extend the life several years longer. It believes adequate protection will be developed to insure reasonably permanent life to the concrete ship.

The economy of the concrete ship cannot be determined until we have had experience over a term of years. The estimated cost of the concrete ship at the present time is approximately $125 per ton dead weight. The cost of a steel ship averages about $200 per ton, and that of a wood ship, $165 per ton dead weight.

If proper coatings can be developed to prevent deterioration, the concrete ship should be a competitor of the steel ship. With further experience it is believed the weight of the concrete can be very materially reduced, thus making the cargo capacity more nearly equal to that of the steel ship.

## Cost of Stucco Finish for Concrete House

Data on the stucco finish for the walls of a concrete house built in 1917 in Darien, Conn., are given as follows by Mr. M. D. Morrill in Concrete:

The stucco finish was put on in a single coat about ¼ in. thick, applied with a plasterer's trowel. The walls were not wet down, but all dry dust was removed. The wall surface was left smooth by the steel forms, and it was at first questioned if there was not danger that this thin coat of stucco would eventually peel off. Experience, however, seems to prove the contrary, and on a considerable number of buildings finished in this way six years ago there is no sign of the separation of the stucco. It appears to be a permanent as well as a rather inexpensive way to finish these steel molded concrete walls. After this stucco was troweled on and had been allowed to stand a few minutes, the surface was gone over lightly with a cork float. A little water was thrown on with a brush, as needed, while the surface was being floated.

In order to get at the exact cost of this wall finish, the time and material used on finishing a surface of 142 sq. yd. was kept, no allowance being made for openings.

LABOR AND MATERIAL, 112 SQ. YD. OF STUCCO

| | | |
|---|---|---|
| ½ day, [illegible] masons, at $4.80 for 8 hours | $7.20 | |
| ½ day, [illegible] helpers, at $3.00 for 8 hours | 3.00 | |
| ½ day, 2 carpenters, at $4.50, scaffolding | 4.50 | |
| Total labor | | $14.70 |
| 2 bbl. cement at $1.92 | $3.82 | |
| 1 yd. sifted sand at $3.00 | 3.00 | |
| Total materials | | $6.82 |
| Total | | $21.52 |

The total cost of finishing these walls was thus between 15 ct. and 16 ct. per square yard.

# Proportioning Mortars and Concretes by Surface Areas of Aggregates

The subject of proportioning aggregates for concretes and mortars is discussed from a new point of view in a paper presented at the last annual meeting of the American Society for Testing Materials by Llewellyn N. Edwards, supervising engineer of bridges of the Department of Works, of Toronto, Ont. Mr. Edwards has developed a method of proportioning which assumes as its basic principle that strength, hardness, etc., of concrete and mortars are primarily dependent upon the relation of the volume of cementing material to the surface area of the aggregate. His paper, an abstract of which is given below, had for its objects the following: (1) To develop information relating to the average surface area of sand and stone aggregates; (2) to describe the methods and materials used, the results obtained, and the phenomena observed in a series of experimental tests undertaken to develop the practical application and efficiency of the method.

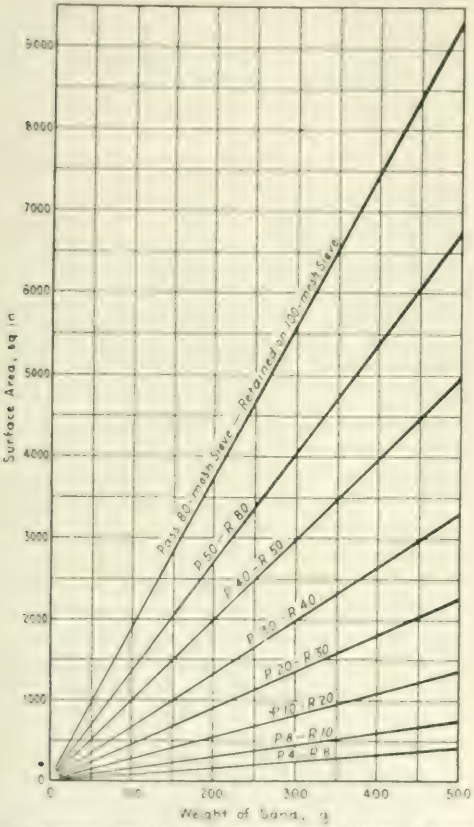


Fig. 1—Surface Area (sq. in.) Corresponding to Various Weights of Sand Aggregate (g.)

The results obtained from the tests are summarized in the paper as follows:

1. That with materials of uniform quality this method provides a means of securing uniformly strong mortars and concretes from sand aggregates of varying granulometric composition.

2. That the strengths of mortars are dependent upon (1) the quantity of cement in relation to the surface areas of the aggregates, and (2) the consistency of the mix.

3. That the strengths of mortars of uniform consistency containing sand aggregates of varying granulometric composition are directly proportional to the quantity of cement they contain in relation to the surface area of the aggregate.

Practical Application of the Surface Area Method. The adaptation of the surface-area method of proportioning mortars and concretes to both laboratory investigations and to field construction operations presents no serious difficulties. The outstanding feature of this method, in so far as its practical application is concerned, is the importance of knowing the granulometric composition of the aggregates. It must be admitted that the securing of this all-important information involves a comparatively small amount of labor, and by way of equipment the use of only the necessary scales, standard sieves and screens. The time element involved is comparatively negligible, since the computation work of determining areas and quantities of cement, may be largely reduced to the most simple mathematical operations by the use of tables and diagrams. For use in the laboratory and in the field, diagrams drawn to a large scale increase accuracy and reduce labor.

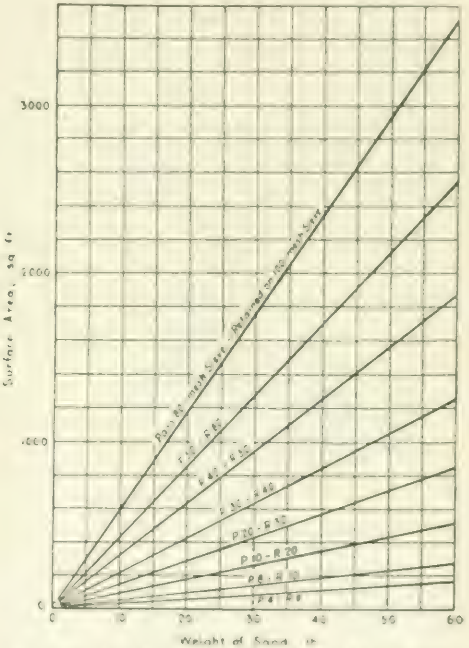


Fig. 2—Surface Area (sq. ft.) Corresponding to Various Weights of Sand Aggregate (lb.)

Figs. 1 and 2 are designed for use in determining the surface areas of sand aggregate. The former is intended for laboratory uses and the latter for both laboratory and field use. These diagrams are derived from computations made by Mr. Edwards. Fig. 3 is designed for use in determining the surface area of stone aggregate and is intended for both field and laboratory use. Fig. 4 is a conversion diagram for determining the relative quantity of cement in pounds per 100 lbs. of sand from the corresponding relation of cement in grams to the surface area of 1,000 g. of sand and vice versa.

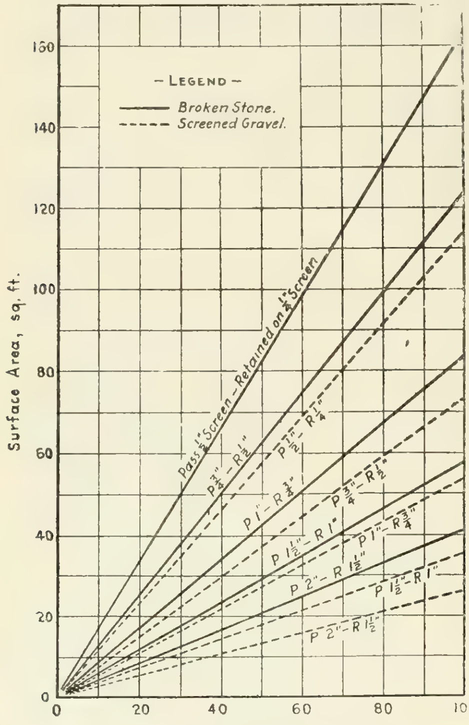


Fig. 2—Surface Area (sq. ft.) Corresponding to Various Weights of Stone Aggregate (lb.).

**Use of Diagrams.**—The following examples explain the method of using the diagrams shown in Figs. 1 to 4, inclusive:

Example No. 1.—Required to find the composition of a batch of mortar using 1,000 g. of sand A and a cement content proportioned, 1 g. cement to 15 sq. in. sand area.

SAND AREA.

| Sieve | Grading, per cent. | Weight, g. | Area (Fig. 21), sq. in. |
|---|---|---|---|
| P 4-R 8 | 15.0 | 150 | 142 |
| P 8-R 10 | 5.0 | 50 | 75 |
| P 10-R 20 | 25.0 | 250 | 694 |
| P 20-R 30 | 15.0 | 150 | 676 |
| P 30-R 40 | 15.0 | 150 | 997 |
| P 40-R 50 | 10.0 | 100 | 992 |
| P 50-R 80 | 10.0 | 100 | 1,348 |
| P 80-R 100 | 5.0 | 50 | 932 |
| Totals | 100.0 | 1,000 | 5,856 |

$$\text{Cement (g.)} = \frac{5856}{15} = 390.5.$$

$$\text{Water (g.)} = \left(390.5 \times 22.2\% \text{ (normal consistency)}\right) + \frac{5856}{210} = 115.$$

Example No. 2.—Required to find the composition of a batch of concrete using 100 lb. of sand A, 200 lb. of broken stone graded as shown below, and a cement content proportioned, 1 g. cement to 15 sq. in. aggregate area.

The area of the sand aggregate is determined as shown in Example No. 1 except that Fig. 22 is used, therefore: Sand area (sq. ft.) = 1,845 sq. ft. per 100 lb.

STONE AREA.

| Screen | Grading, per cent. | Weight, lb. | Area (Fig. 23), sq. ft. |
|---|---|---|---|
| P 1½ in.-R 1 in. | 60.0 | 120 | 69.0 |
| P 1 in.-R ¾ in. | 25.0 | 50 | 41.5 |
| P ¾ in.-R ½ in. | 10.0 | 20 | 24.5 |
| P ½ in.-R ¼ in. | 5.0 | 10 | 16.0 |
| Totals | 100.0 | 200 | 151.0 |

Total area of aggregates = 1,996 sq. ft.
Cement (lb.) = 19.96 x 2.11 (Fig. 24) = 42.12 lb.

**Practical Limitations.**—It is especially important to note that in its application the surface-area method of proportioning admits of certain physical limitations. The more important of these are:

**Effect of Dust.**—The effect upon the physical properties of mortars and concretes of a sandy "dust" passing a No. 100 sieve is not definitely known. The main feature to be considered in this connection is the relation of the sizes of the "dust" particles to the sizes of the cement particles. A microscopic examination of the cement used in the tests described in this paper showed the sizes of the greater portion of the cement particles to range from 1.5 to 3.3 μ.[1] in their largest dimensions with an average dimension of approximately

2.2 μ., that is, $\frac{1}{11,540}$ in. Some of the larger particles measured ranged in size up to 6.7 μ.

Disregarding entirely the effect of the surface tension of the water used in the mix, it is reasonable to assume that the particles of dust do not become "coated" with cement paste, but that instead they become linked to adjoining particles of aggregate by one or more separate cement bonds. Doubtless the cohesion existing betwen particles of cement is greater than the adhesion existing between these particles and the particles of dust or other aggregate. It follows, therefore, that the strength of the mass must be somewhat weakened by the inclusion of dust in the aggregate.

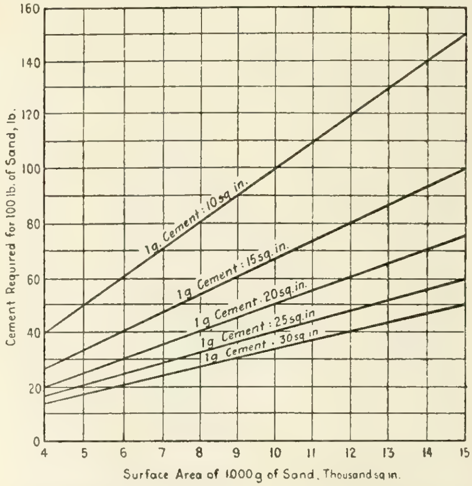


Fig. 4—Weights of Cement (lb.) per 100 lb. of Sand Aggregate Corresponding to Various Surface Areas per 1,000 g. of Sand Aggregate and Various Proportions of Cement to Surface Area.

**Laboratory vs. Field.**—The most important difference between the preparation of mortars in the laboratory and the field is found in the methods of mixing. In the laboratory the operator submits the mix to a thorough kneading and squeezing which forces the component materials into the closest possible contact with each other. In the field the mixing and frequently much of the work of transporting and placing tends to separate and break up rather than to knead and compact the mortar mass.

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[1] One micron (μ) = $\frac{1}{25390}$ in.

Field construction conditions are never ideal, even when carried on under the most careful supervision. In consequence, the strengths and other physical properties of field-made mortars and concretes frequently differ widely from the results obtained by tests made in the laboratory, in accordance with standard laboratory practice, with the object of obtaining a measure of the constructive value of the materials.

**Coarse vs. Fine Sands.**—Mortars in which the sand aggregate contains a comparatively large proportion of coarse particles are subject, during mixing and placing operations in the field, to an intensified movement of the water content which tends to produce an improper distribution of the cement. This condition is most noticeable in concreting operations.

When mixed to "normal" consistency, so-called well-graded sands do not produce mortars which are as "workable" as those in which the sand aggregate contains larger percentages of smaller sized particles.

As compared with mortars containing well-graded sand aggregate, mortars containing agregates composed entirely of fine particles must be subjected to a greater amount of mixing in order to secure a uniform distribution of the cement by a thorough abrasion which will separate the fine particles of aggregate tending to cling together.

**Wet vs. Dry Sand.**—The amount of moisture existing in the sand aggregate constitutes one of the most commonly disregarded sources of variation in the strength of field-made mortars and concretes. Various tests have shown that the surface tension of the water film enveloping the sand particles holds the particles apart, thus producing a decided increase in the gross volume. Sands made up of fine particles, and in consequence having greater surface area, increase more in volume than coarse sands. It is evident that a disregard for this important factor may produce materials the ultimate strengths of which are quite different from those contemplated in the design.

**Conclusions.**—From a careful consideration of the results obtained and of the phenomena observed in the tests the following conclusions appear to be warranted:

1. The claim that the surface-area method of proportioning the cement content of mortars and of concretes is essentially scientific and rational is proven by the uniformity of results obtained in comparative strength tests of mortars and concretes and by the phenomena observed in these tests.

2. With a given uniform proportion of cement in relation to the surface areas involved, this method provides a definite and practical means of comparing the relative strength-producing qualities of aggregates of varying physical, chemical and mechanical properties.

3. This method provides a means for a more thorough investigation of the functions of sand and stone aggregates and for a more complete development of the true values of all the component materials of mortars and concretes.

4. Excess water in an over-saturated mortar or concrete mix exerts a decidedly weakening effect upon the cement matrix by producing a change in the physical structure of the matrix which tends to destroy the cohesion between the particles of cement and the adhesion existing between the cement and the aggregate.

5. In a normal consistency mortar the relation of the area of the particles of the sand aggregate to the cement content of the mix determines the strength of the mortar, provided the strength of the sand material is greater than that of the cement matrix. A similar condition applies to concrete mixes not over-saturated.

6. The strengths of mortars containing a given cement and sand but varying for the different mixes in the proportions of these ingredients, are directly proportional to the relation existing between the cement content and the surface area of the aggregate. It follows, therefore, that the strength of a mortar of given mix being known, the mix of a mortar having a desired strength can be pre-determined for the same materials.

7. The quantity of water required to produce "normal," uniform consistency mortars from a given cement combined in varying proportions with sands having the some origin but varying in their granulometric composition, is a function of the water required to reduce the cement to a "normal" paste and the surface area of the sand particles to be wetted.

8. The increase of volume due to the mingling of varying quantities of cement particles with a uniform quantity of a given sand bears no apparent relation to and is evidently not dependent upon the void in the sand.

9. The tests indicate a probable definite relation between the ultimate compressive strength of the mortar content and the ultimate compressive strength of the concrete when the test specimens of the former are produced from mortar of the same mix and consistency as that used in the concrete.

## State Councils of Defense to Pass on New Building Work

State Councils of Defense will act as representatives of the War Industries Board in passing upon proposed building construction. The procedure will be as follows:

The person interested in a construction project will apply, with a full statement of the facts under oath, to the appropriate local representative of the State Council of Defense.

The local representative of the State Council will then investigate the necessity of the proposed construction and transmit its recommendation, with a summary of the facts, to the State Council for review.

The State Council, of its appropriate committee, will review the case.

If the State Council decides in favor of the construction, it will at once send its recommendation, with a full statement of all the facts, to the nonwar construction section of the Priorities Division of the War Industries Board. The nonwar construction section will then grant or withhold the permit and notify the State Council of Defense and also the individual concerned of its action.

If the State Council decides against the proposed construction, it will notify the person concerned that his project has been disapproved.

The State Council will report monthly to the nonwar construction section all applications submitted to it, including those decided adversely.

The War Industries Board will inform all persons applying directly to it that they must first take up their projects with the appropriate local representative of the State Council of Defense.

# Electric Welding as Applied to Steel Ship Construction

In March of this year the Emergency Fleet Corporation appointed a special committee to investigate and advise the corporation on the status of the art of electric welding and its possible employment in hastening the completion of the steel ship program. An interesting description of the work of the committee was printed in a special supplement of "Nauticus," from which the matter following is abstracted:

**General Features of Proposed Electrically Welded Cargo Steamer.**—The type of vessel selected by the Electric Welding Committee is one which the Emergency Fleet Corporation has already approved, upwards of 100 steamers of this standard type being contracted for in various parts of the country. In adopting this type the committee were guided by the policy of avoiding freakishness of design at the outset, but rather to follow an orthodox form which had proved suited for the purpose intended, with the accepted arrangements as to propulsive machinery, auxiliaries, equipment details, berthing accommodations, etc. The conservative policy has the further advantage of affording an immediate and direct comparison between welding and riveting, with an established type of ship already familiar to the shipping public and the engineering profession.

The leading dimensions of this standard vessel are: Length between perpendiculars, 401 ft.; breadth, 54 ft.; depth, 32 ft. 10 in. There are two decks, with poop, bridge and forecastle and the usual top hamper with deck gear and cargo-handling appliances. Taking, therefore, this type as a basis, the saving in steel due to a redistribution of the material and the substitution of welded for riveted joints, gives the welded ship 500 tons more cargo capacity on the same draft than is obtainable with the identical ship as at present being built. Further, the parts which might be termed the vital members of the structure, have been made heavier and stronger than in the riveted ship and the thickness of the transverse plating on the bottom, sides, inner bottom and decks has been determined mainly from local condition of water pressure, deck-loads, etc., having regard to the adopted frame spacing of 36 in.

The most radical departure in the distribution of material is to be found in the adoption of transverse or vertical plating, instead of the familiar longitudinal or fore and aft method. In the design for the welded ship, however, longitudinal plating has been followed in those parts which are subjected to the maximum principal stresses, such as the topside corners, the keel and the bilges. The keel, center keelson, rider, bilge plate, sheer-strake and upper deck stringer are in long lengths fore and aft, thus reducing the number of joints to a minimum and each of the joints will be designed to provide a positive 100 per cent efficiency.

The modulus of resistance of a midship section of this vessel, taken in way of a cargo hatch and through a butt line of the transverse plating, is 10 per cent in excess of the riveted vessel through the same section at a frame in both the hogging and sagging conditions. It was considered desirable to retain this margin of strength, although the calculations provide generous margins for deficiency in the welded joints of the transverse plating. The estimated efficiency of the welded joints for purpose of calculation is as follows:

| | Efficiency in tension. |
|---|---|
| Joints of fore and aft plating | 100% |
| Joints of transverse plating, overhead welding | 80% |
| Joints of transverse plating, vertical welding | 85% |
| Joints of transverse plating, flat welding | 90% |

All joints in compression, 100% efficiency.

**Type of Joints.**—In the fore and aft plating, butt strap joints are used with one full butt weld and two full fillet welds. These are relatively few in number and short in length and care will be taken to employ only the best welders on them. The butts of the transverse plating are all formed with one full butt weld and two foundation fillet welds reinforced at intervals. In view of their long length, however, it has been considered advisable to allow for an average efficiency of less than 100 per cent.

The scantlings of frames, beams, floors and other local members have been determined in order to provide the same standard of strength as in a riveted ship. Throughout, the types of joints have been determined with due regard to their importance and the nature of the stress to which they will be subjected. In all cases where a plate is connected at right angles to another unsupported plate, a bearing strip is introduced in order to distribute the thrust and reduce the tendency to fatigue. These bearing strips are 3 in. wide, of the same thickness as the unsupported plate and are spot welded to the plate before erection. Bearing strips are not fitted where the plates are backed in cruciform.

The designing work was carried out under great pressure and it is to be expected that further simplification of details, or perhaps slight modifications of design, will suggest themselves as the main idea of "fabricating" ships by the welding process, instead of by riveting, is translated into concrete reality.

**Method of Assembling Welded Ships.**—The elements of design outlined in the preceding paragraphs can be fully understood only by reference to the proposed system of assembling complete 6-ft. welded sections, length to length, into one complete vessel, which marks a radical departure from any system now in existence. The proposal involves completing each 6-ft. section each 8-hour day which, with a 10 per cent margin for unforeseen circumstances, would allow of construction at the rate of 75 working days from the date of beginning work to the vessel proceeding to sea complete and ready to load. With a double shift, the estimated period of 75 working days could be reduced to 40.

Each building slip is provided with a large "Header" which travels along double full gauge track laid at the same inclination as the keel, or horizontally, if side launching is desired. This "Header" is a self contained unit mounting two electrically driven 46-ft. cranes on top, and is divided into six decks carrying the necessary equipment for the welders, pipe-fitters, carpenters, tool shops, foremen's office, and everything necessary for the entire completion of each 6-ft. section. It is also fitted with sliding stagings for the welders, together with arrangements for shoring and clamping the parts for welding. Beginning at the stern end, the "Header" moves forward 6 ft. each day.

The large prepared sections are lifted into position and welded up and all fittings required in each section placed on board and completed, the work being scheduled so that the section is as nearly as possible complete before the "Header" moves forward again. The shafting, engines and boilers are lifted into position and connected up as the "Header" advances, so that the installation can be completed by the time the

"Header" has reached the stem and the ship is ready to leave for sea after launching.

The specification has been drawn with a view to reducing to a minimum the amount of work to be done at the shipyard, the greater part of the welding being done in the shops and by women. This feature alone is of the utmost importance, since one of the greatest obstacles to the execution of the emergency ship program has been the labor question and inasmuch as women are already employed in large numbers in the welding shops, there is no question involved here of drawing upon the labor supply which would otherwise be available for the older fabricating shops and shipyards.

In each normal 6-ft. section of the welded ship there are only six pieces to be lifted into position. The pieces are brought down the side tracks to the "Header" and lifted into position, whereupon the stagings are run out and the day's work begins.

**Amount of Welding Required.**—The following schedule shows the amount of welding involved by the above method on each 6-ft. section and on the whole ship:

[illegible]

[illegible]

| | 6-ft. section. | Total |
|---|---|---|
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| Intermittent welding down, sides and overhead (field) | 200 | 19,000 |

[illegible]

186,000

164,000

[illegible]

The design here outlined has been aimed at producing a structure involving (1) the maximum amount of work in the welding shop, (2) the minimum number of crane lifts at the assembling yard and (3) the minimum amount of welding in the field, all in order to assume completion of each 6-ft. section each 8-hour day.

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**To Enlarge Army Camps.**—Decision has been reached by the General Staff to effect changes in use, size, and capacity of various training camps. The necessary construction will be begun at once by the construction division. It has been decided to establish infantry replacement camps at the following camps: Lee, Pike, Gordon, Grant, and MacArthur. In addition, at each of these points central officers' training schools will be established. The approximate increase in men to be stationed at each camp and the cost of the necessary changes required by the proposed arrangements are as follows:

| [illegible] | [illegible] | [illegible] |
|---|---|---|
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| Grant | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | 1,811,826 |
| [illegible] | [illegible] | [illegible] |

A crew of nine plankers and one foreman at Nilson & Keley Shipbuilding Yard placed 1,893 running feet of planking on a Ferris type hull in 7½ hours.

# The Pay of the Engineer

Interesting comments on the pecuniary rewards of Canadian engineers are contained in the July Bulletin of the Canadian Mining Institute. The Bulletin cites an instance where the Civil Service Commission of Canada advertised for a legal officer at an initial salary of $3,300 per annum and for a chemist for the Mines Branch at an initial salary of $1,600. The qualification required of the latter were such as would entitle him to a Ph.D. degree at any university. On the other hand the duties of legal officer could be performed readily by any mediocre country lawyer or even by a clerk who had a few years' experience in a lawyer's office. The above, states the Bulletin, is only one instance of the invariable practice; it is typical of the government's estimation of the value of the services of a man with high technical training, and one has only to consult the advertisements of the Civil Service Commission, which appear from time to time in "The Canada Gazette," to appreciate the truth of this assertion. During the month of May, for example, a technical clerk was temporarily required in the Topographical Surveys Branch of the Department of the Interior at a salary at the rate of $1,300 per annum, and it is stated that "applications will be considered from graduates in applied science, honor mathematics, or physics, of some recognized university." Qualified draughtsmen, competent to perform engineering and architectural work, are offered $125 per month. By way of contrast, a "motion-picture camera man" required by the Department of Trade and Commerce is to be given an initial salary of $2,400 per annum, and a law clerk an initial salary of $2,100.

Further abstracts from the Bulletin follow: The fact is self-evident that, as compared with other professions, the government sets a very low value on the services of men of the engineering profession, and the possibility for the existence of this state of affairs constitutes a serious reproach against all engineers. Before he can attain proficiency such as required of applicants for positions similar to those for which the Civil Service Commission offers a salary of from $1,200 to $1,600 per annum, the engineer must have spent some of the best years of his life and a very substantial sum of money acquiring the necessary knowledge.

**The Latent Unions of Doctors and Lawyers.**—Those following the professions of medicine and law have certain natural advantages over members of the scientific and engineering professions. Everyone, at some time or another, has need of the services of a doctor, and in a lesser degree, the same may be said regarding the lawyer. Moreover, these professions do not, as a rule, necessitate extensive or frequent traveling from one part of the country to another. As a consequence, both doctors and lawyers are usually able to settle more or less permanently in one place, generally a large center of population. They have better oportunities for meeting together, and one result of this is that both these professions are extremely well organized. It is true that there is no actual "union" of doctors or of lawyers, but it is none the less indisputable that there exists in each of these professions a very strict latent union. There is a well-maintained, if unwritten, etiquette, amounting practically to a taut agreement, whereby certain fees are charged for certain services, and the government or any corporation requiring the services of a doctor or lawyer is well aware that it would be useless to try and undercut these "union" wages. The wage they demand and receive serves to maintain the dignity of their professions, but, broadly speaking, it is not exorbitantly high.

**Engineers Paid Lower Wages Than Unskilled Laborers.**—It is not the government alone which holds the technical professions in such low esteem; this is, unfortunately, more or less universal. Provincial departments and municipalities have followed the lead of the federal technical departments. Corporations and companies are little better in this respect, and it would be very exceptional to find their technical advisers receiving salaries on the same scale as their law advisers, while the mass of their technically trained employes are often paid the same, or even lower, wages than their unskilled laborers. In some of the western coal mines today, mine managers are actually working at the face, because they can earn considerably more money using their muscles than using their brains.

This is really the crux of the whole matter. Ordinary labor, requiring little or no special training or skill, and only average intelligence, has become so highly organized throughout the world that it is in a position to enforce its demands for a fair wage; and like the doctor and the lawyer, labor displays no false modesty in estimating the value of its services. On the other hand, the technically trained man, whose knowledge has been acquired only at considerable expense, both in time and money, and who must possess a fair modicum of ability and intelligence, is at a discount, and this is entirely owing to his lack of organization, and lack of professional etiquette.

**Country Has Need for all Technical Men It Can Obtain.**—This state of affairs is a very unhealthy one, and it is of the utmost seriousness, not only to members of the technical profession, but to the whole country and to the whole world. Wages have reached their present high scale partly as a result of the war, but it would be most unwise to assume that they will be materially lowered during the present generation, if ever. All experience is against this assumption. The wages or salaries of technically trained men have not advanced, or certainly they have not advanced to anything like the same extent. If conditions are to be allowed to remain on this unsatisfactory basis, the outlook for future technical and industrial progress is indeed pessimistic. What incentive is there for parents to go to the expense of sending their sons to the technical colleges or to the universities to learn an unremunerative profession? What encouragement is there for the boys themselves to take up with diligence or keenness the arduous courses of study which are necessary before they can qualify as efficient technical men or engineers, when they realize that they can, with their hands alone, command an immediate independence and very respectable pay? There is something radically wrong with a system under which a university graduate, after four or more years of special study, is only too glad to obtain a position at a salary of $100 or so per month, whereas a man with only one or two months' training can easily obtain work, which is almost purely manual labor, at $5, $10, or even more, per day. Education for its own sake is a fine ideal, but there are few men so altruistic or so affluent that they do not look upon their education as a means to an end, as an investment, which will yield dividends in the shape of a future salary. Moreover, it is well that this should be so; a rapidly growing industrial nation, such as ours, has need of all the trained technical men it can obtain; they are the life blood, without which its industries must soon decline and die. Any policy or condition which tends to discourage the production of such men is suicidal to the growth of all industry, and it is becoming increasingly evident that this condition already exists.

**Salvation of Engineers Rests Mainly with Themselves.**—It cannot be emphasized too often, however, that technical men are themselves mainly to blame for this condition, and that their salvation rests entirely with themselves. There is evident among them an almost complete lack of professional etiquette. A case may be cited in illustration of this. A surveyor in a western town was asked by his council if he would accept a lower salary, and refused. Thereupon he was asked to resign, but was informed that he might, if he wished, send in his application for the positon at the lower salary. This invitation was also declined, but the council had no difficulty in securing another man at the lower salary. It is not necessary here to go into the merits of this particular case, but scores of similar instances might be mentioned where technical men have been willing and anxious to underbid one another in the matter of fees or salary, and the present low status of these professions is the direct outcome of this procedure. This sort of thing would be impossible among men who had any regard for the dignity of their profession, or a proper sense of what was due to themselves, and it can easily be avoided by some form of organization.

**Formation of Union as Means of Relief.**—There seems no obvious reason why professional engineers and technical men in this country should not form a union as highly organized as any of the so-called labor unions. Labor unions have admittedly done much to improve the condition of men working in skilled and unskilled trades, and they are likely to play an even more important role in the future when further readjustments are made between capital and labor. A union of technical men would certainly have the effect of similarly improving the condition and raising the status of those following these professions. That such a union is practicable is shown by the fact that chemists in England have already organized in this way. The fact that technical men follow a great variety of more or less distinct professions, and that the qualifications of individuals are equally diverse, ranging from the consulting man who has had extensive experience to the recent graduate only commencing to practice his profession, need form no barrier to the introduction of a proper scale of fees and salaries. There is the same range of ability and experience among men of the medical and law professions, and the etiquette prevailing in these professions suffices to maintain fees on a well recognized and adequate scale. Even in these professions there are, of course, some who indulge in the practice of under-bidding, but they find themselves severely ostracized. There is no reason why this practice should not be similarly eliminated from the technical professions, and so soon as this is done, the apparent discrimination against technical men will automatically disappear. Those who are at the head of these professions have every reason to know, from their own experience, the hard road their juniors have to travel, especially at the commencement of their career, and the initiation for bringing about the organization which is necessary before present conditions can be rectified or ameliorated, would most appropriately come from them.

# Benefits of Accident Prevention in Contracting*

By [illegible]

[illegible]

Our association has been organized a little over two years and is composed of eleven general builders, or contractors in the building line, who take and perform the operation in its entirety and who do the major part of the work with their own organizations.

One of the first things taken up was the matter of compensation insurance and public liability insurance. It was found that our members were paying about a hundred different rates in about ten different companies, and it seemed to us that with the volume of business in our hands this matter could be brought down to a more businesslike and systematized basis. We considered mutual, state and other forms of insurance, and our decision was to place the insurance of all of our members in one company at a flat rate—and we considered not only the rate, but also the systematic and responsible inspection and other attendant service which we felt could be expected and which bears more particularly on this subject. Our insurance has been in effect less than $1\frac{1}{2}$ years, which is not long enough for us to get a comparison of two distinct periods, but the records of our members show that there have been many less accidents since we started our safety movement than before.

**Well Organized and Systematic Inspection Service.**—In starting this safety movement we had the wholehearted co-operation of the insurance company which has helped us in every possible way to make the movement a success. The very fact that we have this group insurance puts us in a position to demand the kind of inspection and service which we believe could not be obtained otherwise. It holds the service to a high degree of accountability, which is reversing the usual order as between company and assured. It stands to reason that a well-organized, systematic and co-operative inspection service of one insurance company can render better service to a group of ten contractors, acting as a unit, than can be obtained by the haphazard inspection of ten different insurance companies toward ten different contractors.

The inspection by the safety engineer of an insurance company is important, and a man in this position should have great tact, so as not to antagonize the men in charge of a job—he should make suggestions and not give orders. We have had good results from this inspection, and we find that the men are more particular and careful in the erection of mechanical equipment—tower framing is made stronger, cat heads heavier, scaffolds and ladders more secure, etc. In fact, there is more intelligence shown all around, especially by the men in charge. Much benefit has been experienced in the case of employes changing from one contractor to another, as often happens. These men have profited by the system in vogue with their old employers and easily fall in with the same system practiced by the new one.

In the beginning a meeting was called of every one in authority on the pay rolls of our members. We explained the compensation law to them and the scheme of compensation insurance, with its attendant features such as inspection, accident reports, medical service, hospital arrangements, followup methods to find employes who do not continue necessary medical attention and the like. The object of this was to get detailed information and instruction to the men in charge, to rob the system of any criticism of red tape and to dignify the general subject of accidents in the mind of each man in authority, so that he would start out on an individual campaign against everything that might cause accidents to the men working under his charge.

We organized first-aid classes, which were held weekly except in the summer time. These classes are conducted by the medical department of the insurance company and are held in the offices of our association. They are attended by superintendents, foremen, first-aid men and timekeepers, workmen are also welcomed. From charts and practical demonstrations these employes learned not only how to treat accidents, but the importance of taking preventive measures to avoid them. They are taught how to use the first-aid kit which is placed on every job, and we are positive that the coaching they receive in these classes has been of material value in helping to reduce the number of accidents.

**Infection Cases Almost Negligible.**—At the commencement of the new compensation law in Michigan there was great difficulty in getting men to report small accidents which happened to them. Whether this was a matter of pride or not I do not know, but at any rate accidents such as cuts, scratches, bruises, nail punctures, etc., would not be reported. The result was that many cases of infection developed, due to lack of first-aid treatment and subsequent medical attention, and it also resulted in much compensation being paid. Since our campaign for safety has been instituted we find that a large number of accidents have been reported, and at the same time the number of compensation cases has been decreased. This we know to be the direct result of our first-aid classes and inspection service. Perhaps the most noticeable result of this instruction is in the very material reduction in number and severity of cases of infection from wounds. Infection cases, I believe, form the most numerous and expensive class of accidents among employes of general builders, and I am glad to say that our insurance company now reports this class to be almost negligible.

**Precautions on Starting New Building Operation.**—When one of our members starts a new operation the association is notified of the date started, the superintendent in charge and the one who has charge of first aid. It in turn notifies the insurance company, so that the company may immediately send its inspector to the site at the very beginning of operations, instead of later, when perhaps the greatest hazard may have passed. The inspector sees that the first-aid man has a kit and necessary supplies and instructs him as to physicians, hospitals, etc. It is quite probable that this early inspection may result in the voidance of property loss, as well as personal injuries. Proper caution signs and statutory notices to employes are thus not overlooked. Also, if any unusual public liability hazard is present, a report is made which reaches the employer, so that he may increase the indemnity limits on that particular job commensurate with the hazard. Bulletin boards are installed on all the larger jobs, on which are displayed the bulletins of the National Safety Council and our own Association bulletins, with recommendations growing out of the experience of our own members and from other sources.

There is another factor which bears directly on the safety movement which has been greatly neglected, and that is the humanitarian factor. Many times I have heard contractors say that they do not bother with their accident cases—they leave it to their insurance company. This spirit cannot be kept up in this day and age, and the sooner contractors realize it the better it will be for them. The labor turnover in construction work is tremendous, and the chances of accidents increase with each new man put on—to what degree I would not venture to say—but statistics show that the percentage of accidents is far greater in construction work than it is in factory work. You will say that construction work is more hazardous—we all know it is, but even so the percentage can be reduced in a large measure by a little educational work on the part of the contractor. It is of far more value to a contractor to keep one man at work for say 20 days, than 20 men working one day each.

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*[illegible]

**Control of Accidents.**—Our efforts to control accidents, both as to frequency and severity—is first of all to dignify the subject in the minds of employes. Next, to place the responsibility for accidents. If the foreman is educated to the importance of the relation of accidents to the efficiency of his department, and if his discipline is duplicated by every other foreman of his employer, a big step in the right direction is being made. Hold him to his responsibility and support him by keeping up the first-aid, medical, inspection and other service to a high degree. This combination must impress all concerned that an accident is something to be avoided in the first place, or, having happened, it is to be attended to systematically, and measures adopted to make repetition unlikely if not impossible.

## Advantages of Cost Plus Contracts*

By HERBERT E. HEWITT.

Anyone who has tried to let general contract on competitive bids under present conditions knows that it is practically impossible to do so and that it is even less desirable. Two methods then remain. First: Letting separate contracts for each branch of the work on a unit price basis. Second: Letting a general contract for the entire work on cost plus percentage basis. My own experience has been largely with the latter method and it is one I wish to suggest.

In considering this procedure, it is necessary to presuppose a contractor with the following qualifications: (1) Integrity. (2) Financial resources. (3) Buying power. (4) Organization. (5) Executive ability. Some of these are interdependent, but in general they represent the necessaries of the successful contractor, regardless of the basis of his contracts.

"The question is largely one of Buying Power—I shall argue that a building can be more cheaply erected (and generally better and quicker) by a general contractor having the qualifications enumerated above, than by a multitude of sub-contractors whose work is co-ordinated by the architect. In the latter case the architect practically becomes the general contractor, and as architecture is practiced today in this country, he cannot do so to the advantage of his client. The principal reason is that he has no buying power. The statement to a client that the general contractor method is more expensive because he pays the general contractor a profit in addition to the profits of the subcontractor, sounds plausible, but as a matter of fact, the general contractor can buy and sub-let so much cheaper than the architect, that he saves not only his own ten per cent, but in most cases considerably more.

Sub-contractors prefer to figure with general contractors rather than with architects and generally will give a better price to the contractor than to the architect. There are several reasons for this—he is dealing directly with the party who will pay him the money and is not dependent on the architect for certificates or bothered with his too often unbusiness-like methods. The alert general contractor, realizing the advantages to his reputation with those of whom he buys that prompt payment will bring, does not wait until he receives his money from the owner, but discounts his bills and sees that payments on sub-contracts are promptly made. He thus gains for himself a reputation such that he can command the lowest cash prices and a preference in time of delivery or completion over other current work likely to bring slower payment. Further than this, he calls in the lowest bidder on a sub-contract, goes over with him the work to be performed, and is in a position to point out where savings can be made and often gets a substantial reduction on the lowest bid. He becomes a keen buyer, because that is his chief concern. To do all this requires well developed and experienced business ability and a well equipped organization.

The advantage in time required to build has been alluded to above. There is still another advantage and one that cannot be too much emphasized. The element of divided interest is entirely eliminated. The relation of owner, contractor and architect becomes one of co-operation solely—each is striving for the best results at minimum cost and the harmony that prevails assures a successful accomplishment.

## Special Bureau Passes Upon Inventions Submitted to War Department

All inventions of a mechanical, electrical or chemical nature submitted to the War Department for inspection, test or sale are considered by an Inventions Section. This bureau was created this spring for the especial purpose of securing prompt and thorough investigation of inventions. Any persons desiring to submit an invention for consideration, test, sale, or development should do so by letter, giving in order the following information: Name and object of the invention; any claim for superiority or novelty; any results obtained by actual experiment; whether the invention is patented; whether remuneration is expected; whether the invention has been before any other agency; whether the writer is owner or agent; the number of inclosures with the letter. A written description and sketches or drawings of sufficient detail to afford a full understanding of the cases should also be submitted. Should the invention be an explosive or other chemical combination, the ingredients and processes of mixture should be stated. All communications should be addressed: Inventions Section, General Staff, Army War College, Washington, D. C.

**Fifty-seven Per Cent of Fabricating Shop Capacity Contracted for Last Month.**—The records of the Bridge Builders and Structural Society, as collected by its secretary, show that during the month of August, 1918, 57 per cent of the entire capacity of the bridge and structural shops of the country was contracted for.

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*From the August Bulletin of the Illinois Society of Architects.

## Technical Men's Registration Blank

The registration blank for technical men, prepared by A. H. Krom, Director of Engineering, and issued recently by the Division of Engineering, U. S. Employment Service, contains a number of interesting features. In the first place, it is the first official blank of the kind prepared especially for technical men. It is based on a knowledge of their experience and training and is calculated to fit their professional record. It furnishes, at the same time, and unconsciously, a compact history of the engineering profession itself, showing how it has grown and how highly differentiated are its various branches. The engineer of days gone by would hardly know his own branch of engineering if he were to chance upon the new divisions which that card notes. The matter of the engineer and the license is perhaps indicated also for even the layman can see that the services of the engineer can be codified and made definitely available. Inasmuch as the blank printed below is an exact reproduction of the Government form, it can be used for registration purposes. Engineers should fill out the blank and send it to A. H. Krom, Director of Engineering, 29 South La Salle Street, Chicago. The Division of Engineering has been established by the Government for the special purpose of caring for the engineer. It registers the engineers and technical men of the nation, classifies them according to their experience and training and then places them in positions for which they are qualified.

## GOVERNMENT CLASSIFICATION BLANK FOR ENGINEERS.

| EXPERIENCE | | | | | | | | | ENGINEERING | | | | | | SALARY | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Place number of years' practice in proper spaces below. | | | | | | | | | Indicate by X your special classification | | | | | | Give figures on monthly basis | |
| | | | | | | | | | | | | | | | | |
| Consulting | Commercial | Designing, Detailing and Checking | Contracting | Construction - Supt or Foreman | Inspection, Testing and Analyzing | Operation, Valuation & Scientific Management | Surveying—Instrument Man | Drafting—Tracing | CIVIL | MECHANICAL | ELECTRICAL | MINING | CHEMICAL and CHEMIST | Architects, Salesmen and Teachers, give special below | Salary Desired | Lowest Considered |

### CHECK YOUR EXPERIENCE ON SUB-CLASSIFICATIONS

I CIVIL ENGINEERING
1—Bridges
2—Buildings
3—Reinforced Concrete
4—Highways
5—Railways
6—Harbor Work
7—Dams and Reservoirs
8—Reclamation
9—Waterways
10—Municipal
11—Water Supply
12—Sanitation
13—Ship Building
14—Structural Steel

II MECHANICAL ENGINEERING
1—Ordnance
2—Bridge Machinery
3—Dredging Machinery
4—Hoisting & Conv. Mchy
5—Machine Shop Mchy
6—Refrigerating Mchy
7—Steel Mill Machinery
8—Textile Machinery
9—Light Automatic Mchy
10—Marine Engines
11—Automotive
12—Internal Comb. Engines
13—Aeronautics
14—Gas Mfng Equipment
15—Steam Plant Equipment
16—Heat., Vent. & Bldg. Eqpt
17—Industrial Plants
18—Railway Rolling Stock
19—Tools

III ELECTRICAL ENGINEERING
1—Batteries, Ignition
2—Electric Railways
3—Industrial Elec. Appl.
4—Switchboards
5—Light and Power Plants
6—Control Equipment
7—Motors and Generators
8—Transformers
9—Overhead Construction
10—Radio and Wireless
11—Railway Signaling
12—Telephone
13—Telegraph
14—Testing Apparatus

IV MINING ENGINEERING
1—Assayer
2—Drilling Machinery
3—Metallurgist
4—Mill and Ore Dress Mchy
5—Mineralogist and Geolo.
6—Mine Survey
7—Mining Machinery
8—Coal
9—Open Pit
10—Ore Dressing Mills
11—Petroleum
12—Smelter and Equipment
13—Underground Mining

V CHEMICAL ENGINEERING
1—Chemical Plant Equipt.
2—Cement
3—Dye Stuff
4—Explosives
5—Fertilizer
6—Gas
7—Oils
8—Glass
9—Soap
10—Hide and Leather
11—Iron and Steel
12—Paint
13—Photographic Supplies
14—Water Purification
15—Sewerage Treatment
16—Wood By-Products and Preservatives

**Specials**

I am / am not engaged in war work and will / will not leave present location

My age is ______ and my draft classification is ______

Print name ______

Print address ______

**PLEASE FILL OUT AND MAIL AT ONCE TO THE DIRECTOR OF ENGINEERING**

## Regulations of Priorities' Division for New War Construction

Building projects, except those in certain specified classes, cannot be undertaken hereafter without first obtaining a permit from the Priorities Division of the War Industries Board. The extent of the restrictions on nonwar construction was set forth in a Priorities Division circular made public on Sept. 12. Extracts from this circular follow:

Structures, roads, or other construction projects falling within the following classifications are hereby approved, and no permits or licenses will be required therefor:

(1) After having first been cleared and approved by the War Industries Board those undertaken directly by or under contract with the War Department or the Navy Department of the United States or the United States Shipping Board, Emergency Fleet Corporation, the Bureau of Industrial Housing and Transportation of the United States Department of Labor, or the United States Housing Corporation;

(2) Repairs of, or extensions to, existing buildings involving in the aggregate a cost not exceeding $2,500;

(3) Roadways, buildings and other structures undertaken by or under contract with the United States Railroad Administration or a railroad operated by such administration;

(4) Those directly connected with mines producing coal, metals and ferro-alloy minerals; and

(5) Public highway improvements and street pavements when expressly approved in writing by the United States Highways Council.

No building project not falling within one of the foregoing classes shall be undertaken without a permit in writing issued by or under the authority of the chief of the non-war construction section of the Priorities Division of the War Industries Board.

Should one contemplating building conceive his proposed project to be in the public interest or of such essentiality that under existing conditions it should not be deferred, then he will make a full statement of the facts in writing, under oath, and present same to the local representative of the Council of National Defense, applying to such representative for his approval of the proposed construction. Should such local representative approve the construction project, he will promptly transmit the application, stating clearly and fully his reasons for approving same, to the chief of the non-war construction section of the Priorities Division of the War Industries Board, Washington, D. C., for consideration, if need be, for further investigation and final decision. Should the application be finally approved by the Priorities Divison, a construction permit will issue, which will constitute a warrant to manufacturers and dealers who have taken the pledges of co-operation above mentioned to sell and deliver building materials required in the construction of the licensed building project.

The regulations do not apply to buildings under construction. The Official U. S. Bulletin states that under a ruling made Sept. 12, practically all buildings under way may be completed and dealers in building material may continue to supply needed material. The explanatory statement of Judge E. B. Parker, Priorities Commissioner, follows:

Circular No. 21, issued by the Priorities Division of the War Industries Board, under date of Sept. 3, 1918, dealing with non-war construction, applies only to projected buildings and not to those already begun. Where a substantial portion of a building has already been constructed, manufacturers and distributors of and dealers in building materials may continue to furnish such materials for the completion of such building, pending further action by the War Industries Board. The local representatives of the Council of National Defense are requested to make surveys of all building activities in their respective territories and report same as promptly as possible to their state chairmen, together with their recommendations concerning the necessity for the continuance of such construction or deferring same until after the war. The state chairman will in turn forward such reports, with their recommendations, to D. R. McLennan, chief of the non-war construction section of the Priorities Division of the War Industries Board, Washington, D. C.

## Personals

John A. Giles, Commissioner of Public Works of Binghamton, N. Y., has been commissioned a captain in the National Army.

T. J. Richey has been promoted to professor of structural engineering at the Agricultural and Mechanical College of Texas.

Howard M. Ingram, a building contractor of Hagerstown, Md., has been commissioned a first lieutenant in the U. S. Army.

James Robertson has resigned as superintendent of the Benicia Shipbuilding Corp., Benicia, Cal. Paul Parker, an engineer of Marysville, Cal., succeeds him.

Thomas E. O'Donnell has been appointed instructor in architecture at the University of Illinois and Wallace B. Livesay has been appointed instructor in architectural engineering.

Harry L. Shaner, former city engineer of Lynchburg, Va., has been commissioned a captain in the Quartermaster's Department of the Army and has reported for duty at Camp Greene.

John F. Pemberton, C. E. Silbaugh and W. A. Miller have organized the C. E. Silbaugh Co. of Caldwell, Idaho, with a capital stock of $25,000 and will engage in a general contracting business.

H. M. Mayo, former manager of the industrial, immigration and advertising department of the Southern Pacific Ry., has been appointed superintendent of safety over the nine lines of railroads under jurisdiction of Federal Manager W. B. Scott.

John J. Muir has resigned as superintendent of the engineering department of the Bass Foundry & Machine Shops, Fort Wayne, Ind., and has accepted a position as general superintendent of the engineering department of a shipbuilding company at Seattle, Wash.

Andrew M. Lockett, president A. M. Lockett & Co., contracting engineers, New Orleans, La., has been appointed a member of the New Industrial Advisory Board of District Exception Board No. 1, New Orleans. The new board has been created by the government for handling industrial draft claims.

Edward J. Willis, president of the Richmond Electric Works, Richmond, Va., has been appointed engineer for the State Fuel Administration of Virginia. Capt. E. F. Smith, fuel engineer of the Richmond, Fredericksburg & Potomac Ry. and the Washington & Southern Ry., was appointed assistant to Mr. Willis.

W. E. Dunwoody, president of the Standard Brick Co., Macon, Ga., has been appointed a member of the executive committee having charge of the distribution of face, paving and common brick for the United States. The other members of the committee are William Schlake of Chicago, chairman; George A. Base, St. Louis; C. C. Blair, Canton, O., and William K. Hammond, New York.

M. E. Cooley, dean of the engineering department of the University of Michigan, has been made regional director for the district comprising Wisconsin, Michigan and Indiana, in the student army training corps, which it is proposed to institute in the leading colleges and universities of the country. The work is instituted under the war department commission on educational special training, and Dean Cooley, together with 11 other regional directors, is working under the leadership of R. C. MacLauren, director of college training.

Rexford Newcomb has been appointed assistant professor of architecture at the University of Illinois. He was graduated from that university in 1911 with the degree of bachelor of science in architecture; received the degree of master of arts from the University of California in 1915 and the professional degree of master of architecture from the University of Illinois in 1918; director of the art department of the Long Beach Polytechnic School, Long Beach, Cal., 1912-17; principal of the Evening High School, Long Beach, Cal., 1913-17; lecturer in architecture at the University of Southern California, 1916-17, also lecturer to several organizations; was engaged in the practice of architecture in Santa Ana, Cal., 1911-17, and during the past year has been assistant professor of architecture and architectural engineering at the Agricultural and Mechanical College of Texas, serving as acting professor of architecture and architectural engineering from May 1, 1918.

## Obituaries

Joseph W. Jenkins, a civil engineer of Vernon, N. Y., died Sept. 16, aged 72.

William Kerr, for 30 years chief engineer for John Bromley & Sons, Philadelphia, died Sept. 14, aged 72.

John Howe Peyton, M. Am. Soc. C. E., president of the Nashville, Chattanooga & St. Louis Ry., died Sept. 14 at Nashville, Tenn., aged 54.

William Kent, a well known authority on the properties of steel and iron as applied to structural purposes, died Sept. 18 at Garamoque, Ont., aged 68. He was the author of The Mechanical Engineer Pocket Book and numerous other books on mechanical engineering subjects. From 1903 to 1908 he was dean of the L. C. Smith College of Applied Sciences, Syracuse University.

Martin Schenck, formerly state engineer and surveyor of New York, and also at one time connected with the Engineers' Department, New York City, died suddenly Sept. 17 at Albany, N. Y., aged 69 years. Mr. Schenck was born at Palatine Bridge, Montgomery County. He was graduated from the department of engineering in Union College in the class of 1869. Soon after his graduation he went West and was engaged as civil engineer in the construction of railroads in Colorado and other western states. From 1881 to 1882 he was engineer for the contractors on the construction of the West Shore Railroad. In 1883 he was appointed assistant engineer in the improvement of the Hudson River. Four years later he was made chief engineer of the work, continuing in this position until 1891. In 1892 and 1893 he was state engineer and surveyor, and was consulting engineer to the State Board of Health in 1894 and 1895.

## Industrial Notes

B. H. Tripp, special representative of the Chicago Pneumatic Tool Co. on the Pacific Coast, has succeeded M. W. Priseler as district manager of sales for the Pacific Coast territory. His headquarters are at 627 Howard street, San Francisco. The Los Angeles branch of the company at 521 Title Insurance building comes under Mr. Tripp's jurisdiction.

The Lidgerwood Manufacturing Co. has opened its own branch office in the Union National Bank building at Cleveland, Ohio. This office will be in charge of Ernest F. Pegg, who has been handling the Lidgerwood line for the W. M. Pattison Supply Co., their former agents, and is therefore familiar with all the Lidgerwood products.

*Road and Street Monthly Issue*

**ENGINEERING AND CONTRACTING**

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Published every Wednesday by [illegible]

[illegible]

**Roads and Streets—1st Wednesday**
(a) Roads
(b) Streets
(c) Street Cleaning
(d) [illegible]

**Waterworks and Hydraulics—2nd Wednesday**
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power

**Railways and Govt. Works—3rd Wednesday**
(a) Excavation and Dredging
(b) Rivers and Canals
(c) Harbors and Docks
(d) Railway Construction

**Buildings and Structures—4th Wednesday**
(a) Buildings
(b) Bridges
(c) [illegible]
(d) Miscellaneous Structures

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CONTENTS

Government vs. Labor Union Regulation of Competition in Job Getting ... 711
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[illegible]
[illegible]
[illegible]
[illegible]
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## To Conserve Paper

The War Industries Board has asked publishers to conserve paper. Every pound of paper saved releases 3 lb. of coal. Accordingly with this issue we commence using a smaller type face for our editorial pages. By so doing we save 4 pages of text, and at the same time are able to give in 20 pages practically as much matter as was contained in 26 pages of our previous issues.

## Government vs- Labor Union Regulation of Competition in Job Getting

One of the greatest lessons that the war has taught is the practicability of teaching vocations and imparting a large measure of vocational skill in a short time. It is true that some men knew the possibilities inherent in this sort of training long before the war brought the matter to the attention of many millions of men. But there was real need of a general recognition of the merits of specialized, intense courses in the practical arts, and this general recognition has at last been secured, almost at one stroke.

Prior to the war the labor unions were strong enough to put serious obstacles in the path of vacational instruction by school methods. The unions invariably fought for the apprentice system of vocational training. Under that ancient system they were able to limit the number of "students" and to retard their progress to a degree that few people have realized. A shock of surprise comes to most men when they are told that the apprentice system and the "closed shop" reached their logical and maximum efficiency thousands of years ago in India and Asia. The caste system that prevails in those ancient and unprogressive countries is nothing else than the apprentice system and "closed shop" principle carried out with unrivaled effectiveness. The simple expedient of requiring that an apprentice must be the son of a master workman can not be matched for its effectiveness in attaining a completely closed shop. All it needed to make it a perfect system of its kind was to prohibit any man from changing the occupation into which he was born, and this was accomplished by the ultimate evolution of the system of caste.

We see in the economic degeneracy of India and Asia the inevitable effect of the caste system, but most of us are so easily deceived into thinking that a difference in names indicates a difference in facts that we fail to recognize the essential kinship between the modern labor union apprentice system and the ancient caste system. These two systems are blood relatives, brothers of one purpose, and that purpose is to limit competition.

The old "laissez faire" (let-it-alone) school of political economists argued that competition should never be restricted, and they called upon men in the name of freedom to oppose all restriction of competition. But most thinking men have come to see that competition has its economic evils as well as its economic merits, and there is consequently a growing determination to put artificial restrictions on competition. If restriction is to be made effective shall it be by the power of labor unions or by the power of government itself? The answer is about to be fought out, but we may safely predict that the government will eventually regulate all competition. Already it has done so in the public utility and railway field; and if our government continues to train men and women for vocational pursuits, it must inevitably regulate the number who receive training in each vocation.

Many of the principles for which labor unionists and socialists contend are sound. The unions are economically right in urging that the number of men permitted to enter a given trade should be limited. The socialists are economically right in their contention that part of the cause of high retail prices is the existence of unrestrained competition. But in the proposed cures of these economic ills both the unionists and socialists are largely wrong. The one proposes remedies that lead toward the ancient system of class—imposed slavery called caste. The other proposes remedies that largely eliminate the incentive of personal ambition through the public seizure of all profits.

The war has, in many ways, brought to the front great economic problems that have been discussed for generations and that will soon demand solution. It devolves upon every thinking man, and particularly upon those who have had scientific training, not merely to study these great social economic problems, but to take an active part in their solution.

## A Novel Experiment in Teaching and Its Value as a Lesson in Logic

For many years it has been debated whether it is better to present facts to students from a text-book or by the lecture method. Those who have debated the question have apparently not realized that they were trying to solve an economic problem without quantitative data, and that they were therefore attempting the impossible. But the debates have fared merrily, if not scientifically, on. At last, however, one of these debaters has thought it worth while to secure and publish some numerical data bearing upon the subject.

Prof. F. G. Higbee has conducted an experiment in teaching certain problems in descriptive geometry, and has ascertained that after one lecture only 11 per cent of the students were able to pass an examination showing that they had fully grasped the principle that had been discussed by the lecturer. A similar principle was then taught from a text-book, and, upon examination, 75 per cent of the students showed that they understood it.

Further tests were made, as explained in the article by Prof. Higbee elsewhere in this issue. We believe that most of our readers will profit from the reading of that article, not only because it tends to show the superior merit of text-book teaching of certain things, but more particularly because it is a good object lesson in the scientific method of solving an economic problem. We call it an economic problem, and so it is; but doubtless it has not hitherto appeared to be economic, else many more "experiments in teaching" like this would have been made. Wherever the question is one involving the element of time, in learning a principle or fact, it is as truly an economic question as one involving the cost of building a road. In the latter case cost data are evidently necessary in solving the problem of minimum cost of the highway. In the former case, time data are equally essential to a correct determination of the relative merits of the lecture method and the text-book method, but very few debaters have clearly recognized this fact.

It is really astonishing what a multitude of subjects there are upon which men debate endlessly without perceiving that endlessness is a characteristic of qualitative arguments where economics is involved. This habitual failure to recognize the quantitative nature of so many economic problems has been fostered by the unscientific teaching of many subjects, and by the custom of public debating. Debating societies have developed many a glib tongue and have coincidently stunted many a logical mind. Witness our city councils, our state and national legislatures and the editorial columns of our daily papers. A lava of language pours daily forth, burying deep the substrata of quantitative facts. And the pity is that those who so industriously and continuously flow words, rarely recognize the need of experimental data.

Reverting to the article that led to the writing of this editorial, we do not infer from Prof. Higbee's experiment that the text-book method has thus been shown to be universally more economic than the lecture method. It should be particularly observed that his experiment throws no light on the value of lectures as means of inspiring interest and enthusiasm. The spoken word, when well spoken by an experienced teacher of original and sympathetic nature, will always be unrivaled as a mental stimulus, we believe; yet we must admit that this belief is founded only on an experience that has never been measured quantitatively.

## What Is the Value of a Month Saved in Building a Road?

During 1916 and 1917 there were 164 highways finished and accepted by the State of New York. These road contracts averaged 3.5 miles each, and the average time from the award of the contract to the completion was 18 months. If the annual cost (interest, depreciation and repairs) is $1,500 per mile of improved road, and if the average time of construction is 5 months per mile, then the public has saved $1,500 × (5 ÷ 12) = $625 per mile during the average period of road construction in New York State, or $125 per mile per month. But, on the other side of the ledger, what has the public lost during the same period? Mr. S. E. Fitch, of the New York State Highway Department, in a recent article, has answered the question by saying: "The annual cost may safely be taken as the minimum value per year, otherwise it would be a mistake to build the road at all." And he suggests that the state could well afford to give the road contractor a substantial bonus for beating the average construction time. Thus, if 5 months were fixed as the standard construction time per mile of road, New York State could profitably pay the contractor a large part of $125 for each month saved on each mile of road built.

The suggestion is certainly thought engendering. It might be replied, however, that a fragment of paved road is annually worth to the public only a fraction of its annual cost. Thus a 3-mile stretch of paved road ending in mud at both ends, may be worth little if any more to the public than 3 miles of mud. Other objections to this method of valuing the time saved in road construction will occur to the reader, but the fact will remain that some method of measuring that value should be devised and it should be given economic weight either in selecting the contractor or in paying him for his work.

## Taxation of Profits as a Factor in Price Regulation

Henry George, in his "Progress and Poverty," advocated the abolition of all taxes save a tax on land, making that tax high enough to absorb all the rent value of the land. His "single tax theory" was based on fallacious reasoning. Indeed there are few richer mines of fallacies than George's celebrated book, for he had no conception of the logical principle called the "plurality of causes." Nevertheless there was real merit in his suggestion that the public should share in the "unearned increment" in land values.

We are now witnessing a radical application of this idea in the income tax, which is so adjusted as to absorb a large part of the profits of corporations that have benefited greatly from the war. The thought suggests itself that, having once put into effect a system of taxing "unearned increments," there is likelihood that the system will be retained indefinitely. And another thought associates itself with this, namely, that by such a system of taxation the government may partly solve the difficult problem of price fixing.

For several years it has been evident that eventually the government would regulate not only the prices charged by railways and public utilities, but would extend the scheme of price regulation to all monopolies, and perhaps to many partial monopolies. But in the latter case there has existed the objection that if the government fixed a price for any product, some producers would make a huge profit while others would make little or nothing and might be forced out of business. Suppose, however, the government were to absorb all excessive profits by a system of income taxation aimed to prevent "profiteering," what then?

A more serious objection to government price regulation is found in the removal of much of the incentive to reduce costs of production. If superior ability in reducing costs results only in seeing the entire increment in profits seized as taxes, men are apt to cease exerting themselves greatly to improve economic methods and machinery. Already we see the doleful effects that such a price regulating policy

[illegible]

## The Migration of Engineers From Purely Professional to Managerial Positions

[illegible] ly professional into executive occupations. Entering the realm [illegible] first confining their managerial activities to public utilities, factories and mines, they soon enlarged the field to include political affairs. It was in the political arena that civil engineers naturally did more than engineers of other branches of the great profession of engineering.

In his presidential address before the Southwestern Society of Engineers, Dean A. F. Barnes, of the Engineering School of New Mexico A & M College said:

> [illegible] of the hour, if not, in fact, the savior of [illegible] * * *
>
> As to the place of the engineer in the world at the close of [illegible]
>
> [illegible] broken Europe and play the principal role in transferring the [illegible] more being called upon to occupy executive positions both in industrial and in public life.

In the recent primaries in Nevada two former state engineers ran for the gubernatorial nomination, one on the republican ticket and one on the democratic ticket. The former [illegible] re elected. We refer to Gov. Emmet D. Boyle.

Recently the president appointed a civil engineer, Thomas Riggs, Jr., as governor of Alaska. These are but political straws, but enough of them are carried on the breeze to indicate [illegible] will be president of the United States. In recent years the names of Gen. George W. Goethals, a great civil engineer, and John Hays Hammond, a great mining engineer, have been prominently mentioned by the daily papers as being fit "presidential timber." The marked executive ability of another mining engineer, Hoover, as food administrator, has led to his being spoken of as a possible presidential candidate.

Yes, "the world moves" and largely because engineers are moving the world.

## What Should a City Engineer's Annual Report Contain?

One of our journalistic contemporaries pertinently asks: "In the general crusade for economy why not apply it to the saving of a few tons of paper by cutting all useless matter out of municipal reports? Thousands of pages of municipal reports are printed every year that no one reads but the proofreader, and he has to be paid to do it."

The question is timely and the [illegible] has been too little thought given to the utility of the data printed in reports. [illegible] published.

## The Art of Writing Proposal Advertisements

[illegible] proposal advertisement is not satisfactory. The contractor desires first to know the approximate size of the job in dollars. This tells him whether the work is large enough to warrant his shipping his plant to the job. He desires next to know the quantities of the principal items in the bidding sheet. He is not particularly concerned about the minor [illegible] ple, he wants the quantities of excavation and of paving, as well as the mileage and width of pavement. If there is any considerable yardage of culvert and bridge masonry, this should be given. But, as a rule, such minor items as iron culverts, fences and guard rails, etc., need not be stated in the advertisement. The space usually taken up in naming the minor items can be used to better advantage in stating the time limit, penalty and bonus provisions, and other general, but important clauses of the contract.

If the engineer will try to put himself in the place of the contractor who reads the advertisement, he is not apt to go far astray in writing the advertisement. One of the common causes of unsatisfactory proposal advertisements is found in the fact that engineers do not write them. City or county clerks frequently prepare the "proposals," and they can not be expected to know just what a contractor would like to be told.

It is the essence of all good advertising to interest and to inform the reader. Proposal advertising should at all times perform those two functions, but at the present time there is an unusually imperative reason for doing more than merely to announce that "bids will be received" on such and such a date for such and such a kind of work. The city, county, state or government has a job for sale, and a good salesman will always present the facts truthfully, as fully as need be, and attractively.

Recently there have been no bidders at all on several important contracts. It is commonly believed that when no bids are offered all contractors either regard the work as too risky or the conditions as too onerous. But this is not always the case by any means. If the proposal advertisement tells next to nothing about the job, and particularly if it does not indicate what, if any, clauses in the contract relieve the contractor from at least part of the risk, is it to be expected that many contractors will spend time and money to visit the site of the work and study the plans, specifications and contract? Many engineers are prone to blame contractors for everything, even for not bidding. They would be wiser were they to talk, man to man, with a good many contractors, seeking the contractors' viewpoints. It takes two to make a bargain, and if the seller is wholly inconsiderate of the buyer, he is pretty apt to make either few or poor sales. Even when an inconsiderate salesman makes a sale, it is likely to prove a bargain unsatisfactory [illegible]

## The Pay of the Engineer

To the Editor: I have read with much interest the articles in your issue of Sept. 4th, dealing with the salaries of engineers. I am indeed glad to know that your magazine is giving this subject the attention it deserves.

[illegible] most deplorable and I doubt if it is true in a number of the other professions.

[illegible]

money on one job he usually expends all his savings seeking a new position; and, after having followed the practice of his profession for about 20 or 30 years, he finds he has been thrown in contact with a great many people and that he has been privileged to see a large part of this globe, but be neither has home nor bank account.

The engineers have been loath to advertise their work. The layman does not appreciate the value of an engineer to civilization, and when one stops to think that practically everything in this world not made by Nature which is of use to man is the work of an engineer, his importance looms large in the eyes of a few, but the world at large shows little appreciation.

It would seem to me that some organization should be formed to furnish information to the press of this country, showing why engineers are so necessary, what they have done and above all pointing out the fact that they are entitled to a living wage.

History records the fact that it has been and is today most difficult for any engineer to have legislation enacted either in the various States or the Nation; I mean legislation, not particularly beneficial to the engineer from a financial standpoint, but that which deals with the upbuilding of our country. In very few legislatures of the various states do the engineers have any representation—the same is true in the Congress and the Senate of our country, and, on many of the Boards where engineers should be appointed, we find their places filled with men of other professions.

If engineers were taught the art of public speaking and if, as has been stated, they understood a little more about advertising, perhaps they would be able to tell the people what they are, and why they are, and then they would be appreciated a great deal more.

I am glad to see that you have taken hold of this matter in earnest and I sincerely trust that you will consider it of sufficient importance to write about it most freely.

Rodman Wiley,
Commissioner of Public Roads of Kentucky.
Frankfort, Ky.

## Tar Concrete Foundation for Brick Pavement

In an address before the National Paving Brick Manufacturers' Association, Mr. John S. Crandell, gave the following specification for a tar-bound base. The specification was prepared by Mr. Crandell at the request of a number of men in the association:

After the roadbed is thoroughly drained, shaped to section and rolled, a layer of stone or slag 4 in. deep is spread and rolled and the voids filled with sand or screenings. Upon this filled base is placed the waterproofing course, which is rolled on a finished depth of 3 in., and consists of stone passing a 2¼-in. ring, and retained on a 1¼-in. ring. Screenings or sand is then used to fill the voids, and the road is thoroughly rolled until there is no movement of the stone under the roller. Water may be used to help carry the sand into the voids. When the road is dry, a gallon of Tarvia B., cold, is applied per square yard in two uniform applications. The Tarvia is allowed to penetrate the road, and a light covering of sand is added to prevent the roller from picking up the Tarvia. When this has been well rolled, a ¾-in. course of sand and Tarvia B is spread in the proportion of 90 per cent sand and 10 per cent Tarvia. This is spread uniformly, and the bricks are laid on it, following the usual specifications. The joints are filled with pitch or pitch mastic.

**Continuous Dragging of Heavy Traffic Gravel Roads Gives Good Results.**—On some of its heavier traveled gravel roads the Michigan Highway Department has found that continuous floating with a road float gives very good results. In these cases a trip is made over each road every day regardless of weather conditions. It is necessary to add gravel in such amounts as will insure that there is always a thin layer of loose material present on the road surface. This gravel should not contain pebbles larger than ½ to ¾ in. and should contain a sand or loam filler.

# Pavement Planer Method of Finishing Concrete Roads

### By E. EARL GLASS.

On a part of the Pomona Boulevard in Los Angeles County, California, the County Road Department has replaced the bituminous macadam pavement with a half mile of concrete 5 in. thick by 24 ft. wide. The ground water stands only a foot below grade at this point and the macadam failed by overloading the unstable subgrade. A traffic census for the month preceding the replacement shows an average daily traffic as follows:

AVERAGE DAILY TRAFFIC ON POMONA BOULEVARD AT SAVANNAH.

| | | | |
|---|---|---|---|
| Number of horse vehicles | | | 59 |
| Number of motorcycles | | | 56 |
| Number of automobiles | | | 2,626 |
| Number of motor trucks | | | 333 |
| Horse traffic | 116.032 tons | 7.248 ton feet* | |
| Motor traffic | 4,348.136 tons | 271.755 ton feet | |
| Total | 4,464.168 tons | 279.003 ton feet | |

*At 16 ft. actual traveled width of the old road.

The oiled macadam pavement did well to serve 6 years under a heavy motor traffic and these conditions, before repairs became excessive.

Some features of the concrete work, particularly the finishing, are of interest. To permit construction without detouring traffic, only half of the width, 12 ft., was built at one time. The south half of the old macadam was first broken up by a roller and rooter and the stone used as far as possible to reinforce the subgrade after rough grading. When rolled by a 13-ton gas roller, this provided a good, uniform base for the concrete slab.

The forms were an improvement on the 2 in. lumber ordinarily used for headers. Odd lengths of 1 in. x 5 in. boards were nailed together, breaking joints and securely fastened to stout stakes driven at 5 ft. intervals. All stakes were driven or cut off flush with the header to prevent interference with the finishing tools. These continuous, doubled forms were more rigid than the butt jointed, 2 in. strips as there were no joints to yield under the tamping of a heavy templet; they held their alignment better and were easy to fit to curves.

A 13B Foote mixer was used with 1½ bag batches and the slightly stiff concrete, as placed by the spoutman, was struck off with a 2 in. x 5 in. board. It was then thoroughly tamped by the straight templet and about 15 minutes after placing, the surplus water was removed by the roller. This was a 6 ft. length of 8 in. steel pipe weighing 100 lb. Three times over sufficed to leave the concrete dense and workable.

Now follows the tool that makes this finishing method distinctive. It was a stiff straight-edge fitted with long iron pipe handles, hinged at the middle of the board and fitting in a slide at each end so the planer may not be lifted from the forms. The tool was sawed and pushed along on the forms, the excess material being removed as it pushed up ahead of the straight-edge. Wherever the concrete was not carried ahead of the edge, more was added to fill the depression. In this way the surface was struck to a true straight section and not even a slight hump or hollow could get past. Three times over was usually sufficient to leave the pavement as a practically perfect plane. The amount of concrete removed by the planer on an apparently satisfactory surface proves the efficacy of the tool. It will be noted that the concrete strip was only 12 ft. wide. The tool would not prove so satisfactory on greater widths but most of the pavement replacements in this county are built in half-widths for the convenience of the traveling public. The straight half-section is favored for the low crowns of our good roads, as it gives a uniform drainage slope from the center to shoulder, rather than the practically flat mid-section of the curved cross-section.

After the planer, the surface was finished with a 10 in. canvas belt which was sawed over the surface twice to work the top and then drawn straight towards the mixer. The finished surface was of good texture, entirely free from laitance, and will pass rigid straight-edge inspection. Wide Carey felt strips were placed at each noon and night stop.

The felt projected ½ in. and the surface of the concrete had carefully troweled at the joint to avoid the slight ridge so commonly left at the felt joints. The felt was later cut off with a sharp-pointed trowel. This method is found much better than trying to place the felt strips just flush with the surface.

As soon as the concrete was set sufficiently, earthen dikes were built along the edges and across the slab at intervals depending on the grade, dividing it into checks which were kept flooded with water for 14 days to insure proper seasoning of the concrete. Then the earth was removed with a grader and the road opened to traffic.

A small wash near the middle of the job was crossed by depressing the pavement, so as to confine the ordinary flow to the dip. This waterway carries only a small stream for about one month each year and would only interfere with traffic during exceptional floods. These usually last only a few days and the dip, as described has a greater storm capacity than any ordinary bridge or culvert. Mr. F. H. [illegible] is the county Road Commissioner and Mr. [illegible] was district engineer in charge of this work.

Road Sprinkling by State Highway Department.—During the latter part of last season the State Highway Engineer of Idaho placed two auto sprinkling trucks of [illegible] gallon tank capacity at work in the Twin Falls and Pocatello districts on unsurfaced roads. The surface was a light volcanic soil and many places were practically impassable from deep dust and chuck holes. The application of water soon began to bring the roads to a firmer condition, and doubtless was the means of saving the roads in that section from very serious impairment.

# U. S. Highways Council Policy on Use of Bituminous Materials

To meet the enormous increase in the demand for fuel oil due to war activities, it has become necessary to conserve the supply of petroleum, asphalt, and tar products for highway work. Most of these materials are made from raw products which are, either directly or indirectly available as fuel. The general policy of the United States Highways Council in this matter is set forth in Bulletin No. 2 issued recently by the Council. Extracts from the Bulletin follow:

The limited supply of petroleum, asphalt, and tar products should logically be used where it will be of greatest benefit to the country as a whole.

Upon the assumption that the use of a certain amount of these products is absolutely necessary to the welfare of the country and to the successful prosecution of war measures, conservation in general [illegible] purposes, releases, for the manufacture of fuel oil, crude materials which would otherwise have to be used in the construction of road materials. All grades and types of petroleum, asphalt, and tar products are, therefore, classed as potential fuel. Some of these products may be directly used as fuel, others may be made suitable for fuel by combination with other fuels, while others can only be used indirectly as fuel.

The relative importance of different classes of road work were explained in Bulletin No. 1 (see Engineering and Contracting, Sept. 4, 1918). Dust laying is considered the least important use of petroleum, asphalt, and tar products during the period of the war.

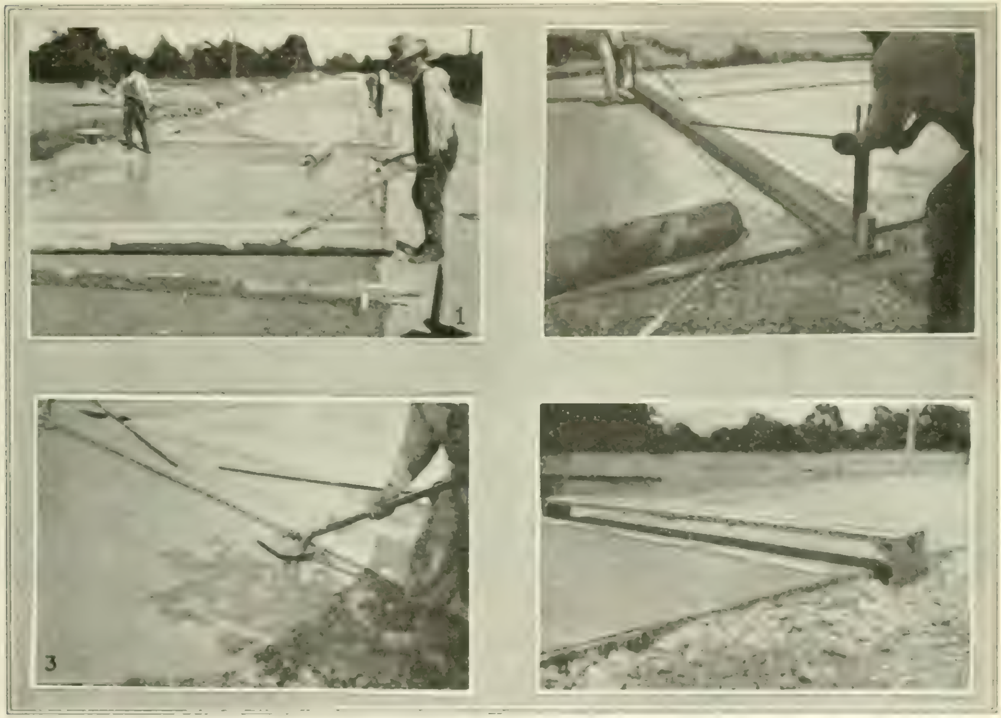

Fig. 1—Finishing Tools. Fig. 2—Pavement Planer in Use on 18-Ft. Concrete Strip, Roller at Left. Fig. 3—Removing Excess Concrete from Straight Edge. Fig. 4—Projecting Edge of Wide Joint Felt and Joint Finishing Bridge. Shows Also Double Board Side Forms.

No hard and fast rules can be applied to the policy governing the release of petroleum, asphalt, and tar products for road purposes. Different and constantly changing production, storage, and transportation conditions exist in various parts of the country, and every application must, therefore, be considered on its own merits in the light of existing fuel conditions at that time.

No special permits are required for the release of fuel oil to be used in the operation of road or paving plants if the project for which the fuel oil is desired has been approved by the United States Highways Council.

No applications for petroleum, asphalt, and tar products will be considered unless approved by the proper state highway department, except that application for materials to be used directly in work for the Federal Government will not require the approval of any state highway department, but must have the approval of the United States Highways Council.

## Crew Organization for Constructing 700 Sq. Yds. Concrete Pavement per Day

An organization capable of turning out 600 to 700 sq. yd. of concrete per day for road construction under conditions prevailing in Western Washington is outlined in a recent issue of the Concrete Highway Magazine, from which the matter following is abstracted.

**Materials.**—In many cases sand and pebbles have been obtained near the road to be paved, and as a rule the sand and gravel banks have sufficient elevation to allow sluicing the material into bunkers. With the many streams in western Washington, water is usually near by in large quantities.

Under these conditions and with the following crew at the pit and bunkers, 250 cubic yd. per day can be turned out.

1 man for pump and engine.
1 man at nozzle sluicing in pit.
1 man helping nozzle man removing large rocks, roots, etc.
1 man at bunkers looking after sand box and keeping chutes clear.

**Grading.**—Supposing the road to be paved is a well developed highway with proper grades established, and that only light grading is to be done prior to paving, the following men will do the rough and fine grading:

1 foreman in charge of grading and ribbon setters.
1 engineer for caterpillar and roller.
1 teamster for Fresno and wheeler.
4 laborers, pick and shovel work.

When caterpillar is hooked to road grader and scarifier one of the above laborers is used on grade as helper. One of the above laborers also is used at times as teamster's helper.

**Ribbons.**—The grading foreman has:

1 man setting ribbons.
1 man helper.

**Placing Material.**—Where the maximum haul is 4 miles, 3 five-ton trucks will handle the output of bunker and put material on ground to run 1 three-sack batch mixer.

**Final Subgrade.**—Two men are required back of mixer bringing subgrade to exact depth and dragging subgrade template on ribbons.

### Mixer Crew for Three Sack Machine.

1 foreman in charge of concrete crew.
6 men used on wheelbarrow for gravel, 3 wheelbarrows with 2 men to each barrow.
2 men are used on wheelbarrows for sand, 1 man for each wheelbarrow.
2 men are used for cement, 1 man carries cement to bench, 1 man empties sacks into hopper.
2 men for spreading concrete.
2 men for rodding.
1 man for finishing.
1 engineer on mixer if gas engine is used. If steam mixer is used a fireman is necessary.
2 men for covering finished concrete with 2 in. of earth.
2 men watering earth covering on concrete less than 10 days old.
1 man watering subgrade
1 man for water supply to mixer.

Presuming that the road to be paved is 20 ft. wide with a 1:2:3 mix and a thickness of 6-in. side and 8-in. center, the crew as outlined above should lay 600 to 700 sq. yd. of pavement per day.

## Proper Method of Application of Bituminous Filler for Creosoted Wood Block Pavements and Floors

By LAMBERT T. ERICSON, Assoc. M. Am. Soc. C. E.
Contracting Engineer, The Jennison Wright Co., Toledo, O.; the Midland Creosoting Co., Granite City, Ill.

The necessity of a bituminous filler for a wood block pavement or floor is generally conceded by all engineers and paving experts, but the consideration of the proper method of application and proper selection of the material to be used is frequently neglected by them. The improper application and the use of unsuitable material has caused, in a number of very prominent places, such obnoxious conditions that wood block paving has had a tendency to fall from the good graces of the public. The ease with which this could be rectified, if taken care of properly in the beginning, and the great difficulty in removing the surplus filler after it is once covered all over the top surface of the pavement, makes it all the more to be regretted.

The bituminous filler is one of the most important features in connection with the whole problem of wood block paving. A great many cases of improper application of the filler have caused troubles which are attributed to bleeding of the blocks and there is no question but that soft pitch on top of a pavement, when subjected to the hot sun, causes every bit as much annoyance as bleeding of the creosote oil.

In the first place, in order to be of any benefit to a pavement, the filler must penetrate to the full depth of the joints. It is important only as it accomplishes this function. The presence of the filler on the top surface is not desirable or beneficial. In order that it shall so penetrate the full depth of the joints, it is necessary to lay the blocks with an open joint construction. Plain rectangular blocks placed tightly together will not permit the penetration of a filler. Construction men are well acquainted with the fact that the bituminous material will congeal near the top of the joints, whenever the blocks come into contact with one another.

Taking it for granted that the blocks are so spaced and laid that the filler will properly penetrate to the full depth of the joints, it is essential that the filler be heated to a sufficiently high temperature to be truely liquid when it is applied. It should be heated to about the boiling point and flushed into the joints from the top with a rubber squeegee. It is not possible to heat coal tar pitch or asphalt to the right temperature in the large tank wagons which are frequently furnished to paving contractors by tar producers. If coal tar pitch is so delivered on the job it should be drawn off into smaller kettles of about 200 to 500 gal. capacity and reheated to a higher temperature, before being used. If this is done and hard rubber squeegees are used to force the filler from the top and into the joints, very little surplus will remain on top. The film will be so thin that, when covered by a coating of sharp sand or stone screenings, the traffic will wear it off in a very short time.

The proper sort of squeegee can be made on the job with ordinary Rainbow red rubber engine packing of ⅛ in. or 3/16 in. thickness, placed between two 1 in. boards, attached to a handle. The rubber should extend out about ½ in. from between the boards and be about 3 in. wide by 18 in. long.

The joints should be filled full at the time of application. When the material cools off it will settle down in the joints about an inch. Further applications are not necessary or desirable since, if the joints are filled completely and swelling of the blocks occurs, it would be forced out on top and become a nuisance.

The top inch or so of the joints should be filled with sand or stone screenings and the top of the pavement should be covered with the same material, allowing it to remain as long as possible and to be worked in by the traffic.

When the bituminous filler collects in undue quantities in spots on top of the blocks it can be broomed into the joints very advantageously [illegible] by asphalt paving contractors. The use of hot irons of that sort has met with great success on a number of large jobs and the combination of the above method and hot irons to remove any accidental collections of the bituminous material on top of the pavement [illegible] a permanent and successful job from the very beginning.

The sand in the top of the joints soon works down and forms a mastic with the bitumen in the bottom. Any attempt to completely fill the joints with sand or cement will result in a continual mess in hot weather.

When the blocks are laid on a cushion of pitch over the concrete base there is frequently danger of floating of the blocks. This floating can be prevented by sifting a little dry sand into the bottom of the joints before the bituminous filler is introduced. The sand forms a dam at the bottom and also stiffens the filler by forming a mastic, in a short time. Care must be taken, however, to see that too much sand is not used, also to use dry sand that will drop down to the bottom of the interstices.

The accompanying photographs illustrate very forcibly the points brought out in this article.

Figure 1 represents a pavement laid several years ago, the blocks being treated with a particularly high grade, high priced oil and laid with open joint construction. The joints were, however, filled to the top with pitch mastic. The contractor was forced to pitch the joints twice. An undue amount was left on top and [illegible] the hot sun hits the street it comes up out of the joints, making a very unpleasant condition.

Contrast that street with the one shown in Fig. 2, where the blocks were treated with ordinary paving oil. This pavement has a pitch mastic filler applied at proper temperature in the proper way. It has never been dirty or caused any inconvenience.

Careful selection and heating of the materials and inspection of the work will correct [illegible] use of bituminous fillers and give us the ideal permanent and satisfactory pavement. The filler is needed not only to cement the blocks tightly in place but to prevent water getting underneath the blocks and collecting in pockets. Superficial water does not tend to make the blocks swell. Elimination of cushions and the use of bituminous fillers will [illegible] but will go a long way toward eliminating expansion and buckling.

When coal tar pitch is used for a filler it should be of not less than 140° F. melting point, and preferably a little harder. A range of 150 to 160° F. melting point gives the best results. [illegible] oil in the blocks will act as a solvent on the tar in the pitch, [illegible] qualities.

**The American Soldier and French Roads.**—The Roads of France, states Major [illegible] Garrett of the A. E. F., in a letter to Judge J. M. Lowe, President of the Old Trails Association, are considered the arteries of the Government and they receive the same careful attention as does an issue of currency or the enforcement of a law." Continuing, Major Garrett says:

[illegible] These giant trucks, [illegible] soldier who has [illegible]

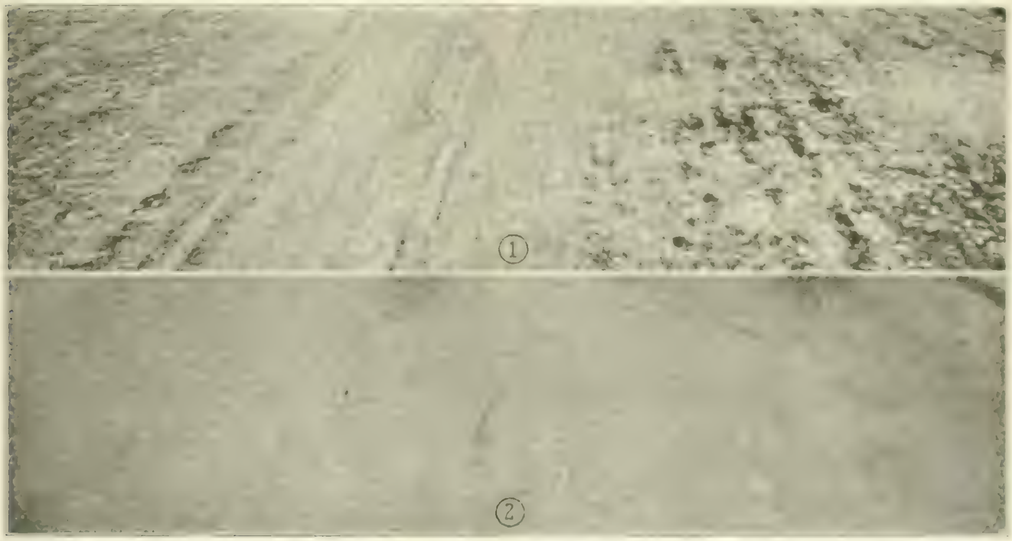

Fig. 1—Pavement Laid With Open Joints Filled to Top With Mastic. Fig. 2—Pavement With Joints Filled in Proper Manner.

**400 Per Cent Increase in Tonnage Moved Over Highways.**—At the conference [illegible] 1918 of the Highways Transport Committee of the Council of National Defense, reports made by the regional chairmen showed tonnage moved over the highways increasing at a tremendous rate, in some states as much as 400 per cent increase over last year being shown. The Cleveland-Akron-Canton area reported 61 per cent as much freight being moved by motor express now as the railroads are carrying.

# Force Account Paving at St. Paul, Minn.*

By OSCAR CLAUSSEN.
Chief Engineer Department of Public Works

Beginning with three paving jobs in 1912, the Department has executed as high as 15 jobs in one year. Out of a total of 59 paving jobs executed during the last six years, 32 were done in competition with the lowest bids received from contractors and in each and every one of these 32, the actual cost of pavement was less than contractor's lowest price bid. While in some cases the percentage of saving was very small, others were done where the contractor's lowest bid was 15 per cent to 25 per cent higher than the actual cost of the pavement laid, the average of all jobs laid in competition being approximately 10 per cent.

**Preparing Cost Estimates for Force Account Paving.**—One of the most important operations involved in connection with force account pavement is the making and securing, as far as it is possible to do, accurate estimates of cost, as these, of course, are the determining element in deciding, after bids are received, whether to let the work by contract or proceed to do it by force account.

The two items of an estimate of cost are labor and material. The quantity of, or amount of material for a piece of engineering work is generally quite definitely called for and prescribed in plans and specifications, and therefore the cost of same can be quite accurately ascertained, but the labor item of the cost estimate cannot be readily predetermined and is very difficult to figure accurately. Therefore, on all engineering work where the percentage of cost of material of the total cost is large, and the percentage of labor is small, it is quite possible to make a fairly accurate estimate of cost, and, on the other hand, where the percentage of labor is large, and the percentage of material small, it is much more difficult to furnish an estimate of cost approximating the actual cost.

Now on paving work, the cost of the material amounts to from 70 per cent to 80 per cent of the total cost, while the labor cost amounts only to from 20 per cent to 30 per cent of the total cost. Particularly is this true with block pavements, such as brick, sandstone or creosote block; therefore it is possible to arrive at fairly close actual cost figures of pavement work, both the quantity of material and its price being definitely known and constituting 80 per cent of the total cost, while the amount of labor is not definitely known but constituting only 20 per cent of the cost. For example, suppose the cost of finished pavement is estimated at $3 per square yard. Of this amount, say, 80 per cent or $2.40, constitutes the cost of material and is within very narrow limits definitely known, while 20 per cent or 60 ct. per square yard of finished pavement constitutes the cost of labor not definitely known and liable to vary greatly. Now, after the pavement is finished, we find that the labor item has been 50 per cent more, or 90 ct. per square yard and the actual cost of pavement per square yard is $3.30 instead of $3; that is, while the item of labor was increased 50 per cent over the estimate, the cost of complete pavement was increased only 10 per cent. The above explanations are made for the purpose of showing that it is in fact possible for the engineer, with proper experience, to give an estimated cost of a paving job that approximates closely the actual cost.

The engineer is in a position to know, within reasonable limits, what a pavement will cost and therefore, in a given case, can figure in competition with a contractor whether he can do the work and save money over the contractor's figures or not. In other words, the risk and chances of estimated cost being largely exceeded are very small. Therefore, because all elements entering into the cost of the work are fairly well known, and we know, within reasonable limits, what the actual cost of a pavement will be, barring accidents or mistakes, which may and do happen once in a while, we are in favor of force account work on pavement.

**Cost Estimates on Sewer and Grading Work.**—This reasoning does not hold good with sewer or grading work which is the work next in importance and amount, as has been previously shown. For instance, in sewer work, the labor cost which is the element of uncertainty, amounts to from 60 per cent to 70 per cent of the total cost for sewers up to 20-ft. diameter and constitutes about 40 per cent for sewers as large as 4 ft. or 5 ft. diameter. If we should find, on a sewer job, estimated at $20,000 ($13,000 for labor and $7,000 for material), that the labor item overran our estimate 50 per cent, the sewer would cost $26,500 or about 33 per cent more than estimated.

An additional element of uncertainty as to cost of sewer work is the unknown nature of the ground and the possible presence of water, quicksand, boulders or rock, therefore, sewer work, whether done by force accounts or contract, is a mere gamble as to cost. Contractors largely guess at the cost and sometimes guess right and frequently wrong.

With grading work similar conditions prevail, while the labor item on grading work generally constitutes 100 per cent of the cost and therefore is uncertain, the nature of the ground is not quite as uncertain as prevails with sewer work.

Therefore, because the cost of sewer and grading work cannot be ascertained and predetermined within reasonable limits, and because, in other words, the element of risk is too great, the Department is not in favor of doing sewer and grading work by force account.

**Reasons for Favoring Day Labor Plan for Paving.**—Other reasons for favoring force account paving are as follows: Where the nature of the work is such that it will admit of employing laborers in squads under a competent foreman, all laborers working together as a unit to accomplish a cohesive piece of work, and where it is impossible for the individual laborer to shirk his allotted quota, where each man must do as much work as the best in the gang and where the best man necessarily sets the pace, work can be done more cheaply and more can be accomplished than on such work where each individual does some work different from the others, where he does some separate job by himself, where one man's work does not directly affect the other man's work; in other words, where there is a chance for an individual to loaf on the job. On paving the men largely work in squads. To begin with, there is the grading crew, then comes the concrete crew and then the block laying crew of the asphalt crew on asphalt work. Each man in his crew must work like a link in a chain, all doing equal amounts of work and if one link breaks the entire operating mechanism is thrown out of gear. Laborers appreciate that this cannot be and is not tolerated and in fact do not ask for it. It also necessarily means, in the nature of things, that strong husky men must be employed, men that can accomplish a day's work. In this manner very efficient work is accomplished on paving operations in contrast to a good many other municipal operations.

Another reason why the Department of Public Works favors force account paving is that on the whole, better work can be secured. It is not because contractors attempt deliberately to skimp the work. It is not intended to make this charge. However, contractors do rely and have a right to rely on the city's inspectors to watch the work and see that it is properly done. For the securing of good workmanship, the city must necessarily rely on various inspectors, more or less competent. Such men as the city can secure have at best only a limited knowledge of paving requirements, they are men whose technical qualifications are not of a high degree with reference to construction of pavements and whose salaries are low and whose employment is of a temporary and shifting nature. These inspectors cannot be employed throughout the year and their services are needed only for a few months through the summer season and each season a large number of new inspectors are employed. Men of special knowledge and experience who can command and get adequate salaries, cannot, except in rare cases, be secured by the city under above conditions. Another element in favor of force account work is the fact that the department keeps a very close record of all the labor operations carried on, as well as of the constantly varying costs of material, and in this manner valuable cost data and especially at our disposal, allowing us to keep a close check on any bids submitted by contractors with reference to the profit figured in the job. Thus the contractor is always compelled to figure his work with a small margin of profit and submit a low bid. In this way even if the work is done by contract, it is done at a lower figure than it would be done by competition with force account eliminated.

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*From a paper presented before Engineers' Society of St. Paul.

The primary reason, however, for the Department of Public Works favoring force account paving is the belief that a large saving in the cost of the work can be accomplished. The department does not by any means, favor, that all pavements should be laid by force account. Each individual paving job should be considered by itself. At times the city may not have the proper organization at its disposal, at times it may not have the proper equipment readily available or it may have more work to do for periods than can be conveniently handled, also the contractor may have made a mistake on bidding, for some reason or another, a lower figure than the department has estimated the cost of the work. At times the contractor's judgment as to the cost of the work may vary considerably from that of the engineer, and where this judgment dictates a figure considerably lower than the engineer's figure, ordinary prudence should demand that the work be performed by the contractor.

The Department of Public Works has never claimed that in all cases paving should be done by force account, it has never claimed that in all cases the work could be done cheaper by force account. Being just mere human beings it is certain that on one or the other case the engineer's judgment will be at fault and the cost of a paving job will be more than the contractor's lowest bid price. Particularly is this true at the present time when prices on material are varying from week to week and the element of labor expense is almost impossible to take into account adequately.

To date the Department of Public Works has executed 32 paving jobs in competition with contractors' lowest bid price and in each and every case a saving has accrued. The total saving on these 32 jobs amounting to $73,000, exclusive of depreciation charges. During the years 1913 and 1914 all paving work was ordered done by force account by the council without receiving bids from the contractors, and therefore on the 26 jobs executed in 1913 and 1914 by force account a comparison of contractor's bids cannot be made. However, the work done in 1914 comprised the largest program in paving ever carried out in this city in any one year, the cost amounting to $760,000 equal to 23½ miles on the basis of a 27-ft. roadway.

**Waste of Perishable Foodstuffs Due to Inadequate Transportation Facilities.**—Fifty per cent of the perishable food stuffs produced in America are wasted, largely through ineffective means of getting it to the market, stated Herbert Hoover, Federal Food Administrator, at the recent conference of the Highways Transport Committee of the Council of National Defense. Fast, intimate service by rural expresses, he foresees, will be a great source of saving. By the use of motored expresses, Mr. Hoover pointed out, the farmer need not maintain so many draft animals on the farm, animals that eat the crops of millions of fertile acres that otherwise could be devoted to raising food for people. The failure of the public market in America, Mr. Hoover said, was caused by inadequate transportation of an intimate sort, and he believes that a developed rural express will give public markets a basis of economic success and tend toward lower price levels.

**Road Mileage of United States.**—The total public road mileage of the United States increased from 2,199,645 miles in 1909 to 2,445,760 miles on Jan. 1, 1914. Of this latter 527,291 miles were surfaced road. At the end of 1909, 190,476 miles had been surfaced. Thus in 5 years there was an increase of 246,000 miles of new road, while in the same period there was an increase of only [illegible] miles of surfaced road.

# Employment of Women on State Highway Construction

By HERBERT A. NUNN,

State Highway Engineer.

The State Highway Department of Oregon has employed a small number of women during the past summer on highway construction, and generally speaking we have found that the experiment (if it may so be called) is a success, and it is the intention of the Oregon Highway Department to continue the employment of women.

Contrary to the general opinion of the public, women have not been employed on our work because of an actual scarcity of men, but because we believe that in certain lines of work they are equal, if not superior, to the male sex. It is a familiar fact to all engineers that most of the men applying for work with an engineering department will look for something light, and an application for a position generally states that the man would like to be superintendent of construction, or foreman, and if no vacancies exist in those two departments, would like a well paid position inspecting, keeping time or checking materials. In fact, only about fifty per cent of the young men requesting positions with us this year have wanted to do anything in the line of manual labor, and it was because of the fact that most of the young men applying for positions with this department were unwilling to do a real man's work, that we decided to give the women a chance.

There are some handicaps, however, to the employment of women in engineering parties and on actual construction, principal of which is the fact that most of the camps in Oregon are located at some distance from towns and villages in unsettled districts, and it is hard to find proper accommodations for them. In large construction camps, where a large number of transient laborers are employed, it is not practical for women to live at the main camps. In most cases, however, this has been overcome by establishing a separate camp or getting accommodations for them with farmers.

We find that women are well fitted for many important positions in highway work in the field, most important of which are timekeepers, inspectors of pavement, inspectors of materials, bookkeepers and, in some cases, are well fitted for heavier work, such as driving automobiles or operating light machinery.

The position of inspector in highway work at this time is one of importance, not only requiring ability but honesty, and we find that women take a very active interest in this work, and, as to honesty, no one will dispute the superiority of woman over man. Women are particularly successful in checking materials delivered on construction work and send in neat and careful reports; in fact, reports submitted by the women of our department are far superior to those submitted by the men.

In the operation of light machinery, women have also proved their ability, and there is at least one case in Oregon where a young school teacher has spent this summer in operating a gasoline roller, to the complete satisfaction of the superintendent of construction. They drive cars as well as men and are particularly conscientious in being on time for work.

In the engineering offices, women are employed in drafting and computing as well as in stenographic work. Every business man is well aware of the fact that he soon learns to depend upon the good memory of his stenographer.

In all construction camps, there are a large number of married men, including engineers, superintendents of construction and foremen, and in most cases their wives like to live in camp with them, or at least live as close to the camp as possible, and many times these wives find that time hangs somewhat heavily upon their hands, as they are not doing regular housework and perhaps have only the care of a small tent. It is mostly these women that have accepted positions with the State Highway Department this year and the additional money earned by the wife is a big help, especially to the young engineer who has only reached the position of instrument man and is drawing less salary perhaps than some of the actual labor.

There is no doubt that a large field exists for the ambitious woman in engineering or construction work during the war and we have every reason to believe that they will be as successful in field work as in teaching or in office work. The work in the open air is pleasant and healthful and the women who are employed at this time are enthusiastic over the possibilities. We pay the same salaries to women as to men for the same work.

## The Student Army Training Corps Established at 400 Colleges

About 400 colleges have been accepted by the government as training posts to supply highly trained men for the army. Under this plan any physically fit draft registrant, 18 years of age or over, who is prepared for college, may present himself at one of the selected schools and be inducted into this Student Army Training Corps. He then becomes a private soldier in the army of the United States, subject to the articles of war, entitled to the uniform, equipment, pay, quarters and rations of the soldier.

Enlisted members of the Student Army Training Corps will be subject to a strict military régime, involving a certain amount of daily drill and military work, with the remainder of the time devoted to the pursuit of academic studies approved by the War Department. Provision will be made for periods of recreation and rest.

Enlisted men of the Corps will remain in college until their draft numbers are called, whereupon as the needs of the army require and the authorities of the War Department direct they will be transferred: (a) to a central Officers' Training Camp; or (b) to a Non-Commissioned Officers' School; or (c) to a cantonment for duty with troops as privates; or (d) be assigned to the school where they are enlisted for further intensive work in specified lines for a limited time; or (e) be assigned to the Vocational Training Section of the Corps for Technician Training.

Each man's personal attainments and the momentary needs of the army will determine the disposition made of him.

A certain percentage of the abler men enrolled in the work of the Eechnical Staff Corps—medicine, engineering, and chemistry, may expect to complete the usual course for professional training, although it is intended to employ substantially less time than usual to finish the course. Men who are intending to enter the service of the line, if they give promise of making satisfactory officers, and if they are not over 18 years of age, may probably expect to remain in college one or two years at the outside. Older men and those giving less promise will presumably remain a shorter time. Here, again, the momentary needs of the army will determine the policy.

**Badgers Make Road Maintenance Difficult.**—In some portions of Nevada badgers, which are very numerous, burrow holes in the wheel track of the road. It is the general opinion that this location is selected by the animal in order to secure a firm walled burrow. Under traffic these holes rapidly develop into large chucks which in the dry summer can be repaired only by filling them with gravel or shale shoveled from a wagon.

**Illinois Doing Road Work by Force Account.**—Because of difficulty in securing satisfactory bids the Illinois State Highway Department is now carrying out some of its road building by force account. The department owns considerable equipment which was used some years ago in constructing object lesson roads. Four outfits are now at work and it is expected to build about 10 miles of road this year.

**Cleveland Making Plans for "After the War" Construction.**—Department heads of Cleveland, O., have been requested to furnish the Mayor with an outline of needed public improvements. The City Commission will then pass on these reports and on approval, preliminary details will be worked out so that actual construction can be started as soon as the war is over.

## A Review of the Movement for Excess Condemnation for Public Improvements

The excess condemnation method of taking, in connection with a public improvement, of more land than is needed for the precise narrow purpose of the improvement, is generally considered a new proposal in American cities Nevertheless, it was given its first trial in the United States. New York City exercised the power of excess condemnation beginning in 1812, and Charleston, S. C., also employed this method about the same time. However, these laws were little used because they were early held invalid by the courts, and it was not until recently that American cities have again asked for this power. The greater interest in city planning during the past 15 years in this country has stimulated interest in the subject and has shown the need for this power. Since 1904 there has been several constitutional amendments adopted and enabling laws passed by the various states. An interesting review of the excess condemnation movement is given in a recently issued report of the Chicago Bureau of Public Efficiency, from which the matter in this article is extracted.

**Excess Condemnation in Europe.**—Excess condemnation, however, has had long and extensive use by European cities, especially London, Paris, and Brussels. Canadian cities, notably Montreal, have been highly successful in carrying out projects for the adjustment of the street layout through the power of excess condemnation. The City of London was granted this power in 1845; the City of Brussels in 1867, and it was used by the City of Paris from 1852 to 1869 when many of the beautiful thoroughfares of that city were built.

While the legislation in London and Paris was originally designed to give these cities the power to acquire only remnants, excess condemnation early was used more as a financial measure for the purpose of recouping a portion or all of the cost of the improvement, because the practice of levying on abutting property owners special assessments to pay for the cost of improvement has not been so generally accepted and used by European cities as by American municipalities.

From the financial standpoint, it is doubtful whether European cities have been able to secure as effective results in defraying the cost of street improvements by acquiring surplus lands through condemnation proceedings and then selling them after the improvement has been made as Chicago and other American cities have been able to secure by the special assessment method. However, in some of the recent larger improvements the London County Council has combined the special assessment system with excess condemnation with very satisfactory results.

**Profit from Sale of Surplus Land.**—It has been only in isolated cases that a profit has been made by municipalities in street improvement undertakings through the acquisition of surplus lands and their resale, although in many cases the municipality has been able to recover through sales a considerable portion of the cost of an improvement, the burden of which would otherwise have fallen wholly upon the taxpayers. In London up to 1913 the greater city had exercised the power of excess condemnation in 90 street proceedings. The aggregate cost of these improvements, including the cost of surplus lands, was approximately $121,000,000, while the public authorities were able to realize through the sale of land and through leases nearly $50,000,000 (including the value of land undisposed of), making the net cost approximately $71,000,000. In one undertaking, the opening of Northumberland Ave., the municipality made a clear profit of almost $600,000, and in the building of the Kingsway from Holborn to the Strand it has been stated that the final cost of the improvement was almost $5,000,000 less than was estimated would have been the cost if only the properly absolutely required for street purposes had been acquired. The financial results to the City of Paris during the period from 1852 to 1869 were not so satisfactory. The city built about [illegible] miles of new streets during this period, paying damages for land and buildings acquired amounting to [illegible]. At the end of that period it had sold part of the excess lands for [illegible] and still had on hand property valued at over [illegible].

The prices paid by both London and Paris for property acquired through condemnation, it is generally agreed, were excessive. In Paris the amounts of juries were in many cases out of all proportion to the actual value of the property. Also in London the Parliament has allowed 10 per cent in addition to a fair market value as an offset to the loss of future increment of value in the property and as compensation for expense incurred by the owner in the [illegible] of his lands. Another large item of expense [illegible] in these examples [illegible] the practice of erecting buildings and establishing businesses as soon as an improvement was contemplated, so that a profit could be made when these improvements had to be condemned for the new street. In Chicago there is no allowance for building improvements made after the petition has been filed in court, but the municipality must pay for improvements made prior to that time even if they were put in after the City had decided to make the improvement.

**Excess Condemnation in Belgium.** In [illegible] the excess condemnation act was passed for the purpose of improving the sanitary conditions or protecting the surroundings of public improvements, and in this respect the law has been very successful. Brussels has not been as successful as her Belgian cities financially because of the highly speculative policy adopted by that city, but other Belgian cities have been able to carry out their improvements without financial loss and in many cases at a profit. With the use of the method of excess condemnation, the main section of Brussels was reconstructed from a highly congested area where the streets were narrow and ill-adapted for traffic, and sanitary conditions generally bad, into a beautiful and valuable business center for a modern city. Belgian cities generally have made effective use of excess condemnation in securing beautiful and fitting surroundings for new thoroughfares and public places.

**Experiences at London, England, and Montreal, Que.**—In [illegible] London has used the power of excess condemnation for the purpose of controlling the development of the abutting property along new thoroughfares. On both the Kingsway and the Mall improvements restrictions were imposed to secure harmonious architectural effects and appropriate use of new buildings erected. Many of the famous boulevards of Paris were built by Haussmann during the period of 1852-1869, and excess condemnation was employed to obtain surroundings which were in keeping with these thoroughfares.

The experience of Montreal in using excess condemnation has been highly successful, even from the financial point of view. In the three projects carried out before the war a profit was made by the municipality in each case. In the opening of the St. Lawrence Boulevard the profit was over $29,000. Just before the outbreak of the war the City of Montreal acquired a large amount of property in connection with the building of St. Josephus Boulevard, but this property has not been disposed of because the market at this time is not favorable on account of war conditions. Other Canadian cities, such as Halifax and Toronto, have used the power of excess condemnation to deal with small remnants left after an improvement is made, but have not used it in such extensive manner as has Montreal.

**Excess Condemnation in the United States.** While a number of American states have secured constitutional amendments and enabling legislation permitting cities to exercise the power of excess condemnation, that power has been used only to a very limited extent by American municipalities. Reference has been made to the early beginnings of the use of excess condemnation, but practically nothing was done except in isolated cases until 1903, when a legislative commission of Massachusetts made a report on the subject. As a result, the Massachusetts Remnants Act of 1904 was passed which permitted municipalities to take title to any remnants left which in themselves were unsuitable as building sites. [illegible] by legislation in Virginia, Connecticut, Pennsylvania, Maryland, Wisconsin and New York.

[illegible] playground, for the purpose of protecting such improvements. [illegible] The Massachusetts [illegible] act of 1904 was sustained, to be sure, but the Supreme Court, in opinions given the legislature, said even that act stretched the constitution, and it refused to approve excess condemnation on broader lines under the constitution as it then stood. The broad enactments on the subject by the legislature of Pennsylvania were overturned by the Supreme Court of that state.

**Constitutional Amendments and Special Acts.** [illegible] 1911, and it was followed by amendments in Ohio and Wisconsin in 1912, New York in 1913, and Rhode Island in 1916. These constitutional amendments provide, generally speaking, for taking property in excess of actual needs [illegible] to form suitable building lots abutting upon a [illegible] improvement, and permit the sale of such surplus property with or without restrictions after the improvement is made, so that public control of the surroundings of a new street may be secured.

Since the constitutional amendment was adopted in Massachusetts, a number of special acts have been passed granting cities power to condemn additional land. In only one case, however, has an improvement been carried out in this way, namely, the widening of Belmont St. in the City of Worcester, but this work has not as yet been completed and figures are not available as to the financial results. The City of Springfield, Mass., has also carried out an improvement, but this was done under the authority of the Remnants Act of 1904. The City of Philadelphia used the act of 1907 in the building of the Fairmount Ave. parkway, acquiring land on both sides of the street, then reselling the property with restrictions as to use. In the course of the proceeding, however, the Philadelphia act was held unconstitutional in the case of the Pennsylvania Mutual Life Insurance Co. v. Philadelphia, and the municipality was prevented from using this power further. It has, nevertheless, purchased additional property along the line of the improvement, with the object of protecting the surroundings of the new parkway. While Philadelphia has been unable to acquire sufficient property to exercise the necessary control over abutting properties, the city proposes to build an Art Museum, Library Building, and Convention Hall fronting on the new parkway, and thus set the architectural standard for the new street.

The City of New York has been given the power of excess condemnation by enabling legislation passed in 1915 and 1916, but as yet no use has been made of this authority.

**Possible Financial Results of Excess Condemnation Under American Conditions.** There are few data based upon actual experience indicating possible financial results of excess condemnation under American conditions, but an exhaustive report made for the City of Cleveland in the proposed extension of Carnegie Ave. is of value in this connection [illegible] attained by the City [illegible] sections; one, between 14th and 22d Sts., opening up a new thoroughfare through the downtown district, while the second part of the extension from East 89th St. to East 100th St. was to run through a residential neighborhood where there would be little change in the kind of use of abutting property after the improvement should be made. In section one the cost of the property to be destroyed for the actual widening of the street and the consequential damages which the city would be required to pay was estimated at $347,565. That would be the cost to the municipality for this portion of the new street if it were permitted to condemn only property actually required for street purposes. The appraisal company estimated an enhancement in land values of property not required for street purposes amounting to $437,609; so that the city would make a profit of $90,044, instead of having a loss of $347,565.

In the other part of the street, the extent of property to be destroyed, land taken, and consequential damages to property not to be taken were estimated at $204,910, and the enhancement in land values in surplus lands acquired at $126,989; so that the net cost would be reduced from $204,910 to $77,921. On the entire improvement there would then be a net profit of $12,123, instead of a loss of $552,475. The figures above are for land and buildings proposed to be destroyed or taken, and do not include the cost of building the street, which would be the same whatever method of condemnation were used; or selling and miscellaneous expenses, which would reduce the returns to the municipality. This report also indicates that excess condemnation as a financial measure is only of special value when the change in the street layout makes abutting property available to a much higher commercial use. In the downtown section of the improvement new business frontage would have resulted, and there would have been a large increase in values, but in the other section of the improvement the increase in values would have been small, because the street is in a good residential section where land values were already high and the land after the improvement could not be put to a new use.

## Mechanical Stone Chip Spreader With Improvised Motive Power

A mechanical stone chip spreader with improvised motive power is employed by the State Highway Department of Pennsylvania on bituminous surface treatment work. The rear wheels of a Ford roadster were removed and replaced by a special tractor attachment costing $150. The front wheels of the chip spreader were removed and the spreader connected with the tractor axle by means of a special bolster. This arrangement gave sufficient height for the tractor wheels to turn directly under the chip spreader. This made it possible to operate two of these machines with one operator, one machine being loaded while the other was distributing. It was found that the equipment had ample power to haul a full load of chips no matter how steep the grade. The arrangement was convenient and was operated very economically.

Mechanical Chip Spreader Attached to Ford Roadster.

**Resurfacing Macadam Roads with Loam Filler Gravel.**—The Michigan Highway Department has used 2 to 3 in. of a loam filler gravel for resurfacing macadam roads. The maximum size of pebbles ranged from ½ in. to ¾ in. The road is then patched in the same manner as gravel surfaced roads.

# An Experiment in Teaching*

By F. G. HIGBEE,

Professor and Head, Department of Descriptive Geometry and Drawing, State University of Iowa.

What is the best method of presenting facts to students? Do they learn more quickly by studying from a text-book, or by hearing this same subject-matter explained by an instructor and illustrated on the blackboard?

The following data are presented here in the belief that they throw some light into this rather obscure angle of teaching.

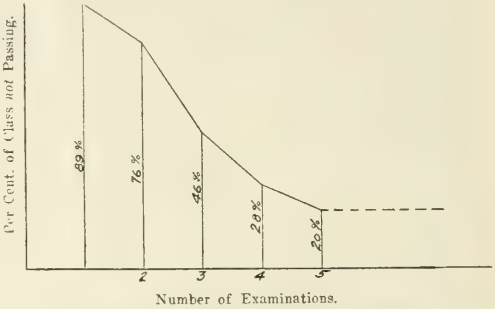

Fig. 1—Result by Lecture Method; Intervals Between Examinations Were 7 Days.

**The Problem.**—The subject-matter to be learned was a proposition in descriptive geometry involving a definite principle. Since no text contained an explanation of this principle it was necessary to resort to the method of a blackboard demonstration.

**The Method of Teaching.**—In presenting the problem to the students it was first very carefully stated and the given conditions and required results thoroughly explained. Using the given data a demonstration was then presented accompanied by an illustrative figure on the blackboard which was built up line by line as the demonstration proceeded.

After several class periods had elapsed, and ample time for study had been given, an examination upon this principle was given.

As would be expected, some students failed to pass this examination—failed in fact, to understand the principle which had been the subject of the lecture. These students were then required to work out this principle under supervision until it was thought that they understood it. Following this a second examination was given. Both those

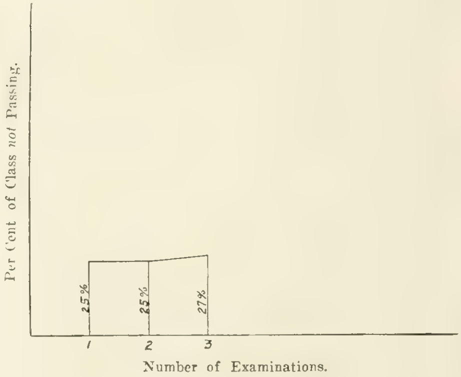

Fig. 2—Result by Text Method.

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*From the Bulletin of the Society for the Promotion of Engineering Education.

who had passed the first examination and those who had failed it were required to take this second examination.

This same process, covering each time the same principle, was repeated for four or five examinations, and with three different groups of students during three different years.

**The Result.**—The curve, Fig. 1, is a composite. It illustrates the general result for all groups rather than the exact result of the tests of any one group. It very accurately expresses, however, the results obtained from this method of instruction. Vertical distances represent percentages of the class not passing any given examination; horizontal distances represent both the number of opportunities or examinations and the time allowed for preparation.

In general it will be noted that about [illegible] per cent of the class never mastered the principle involved and that it required about four trials before that portion of the class which could master the principle actually did master it.

This let it be remembered was the result of the lecture method. Let us now examine the effect of teaching by text-book without the lecture.

**The Problem.**—At this time a text was adopted for use which contained a complete explanation of this principle which was proving so difficult for students to understand. The statement of the problem, the given, and required data were identical, and the method of explanation in the text was the same as that followed on the blackboard. The only differences between the methods of presenting the subject matter were these—in the text the student was presented with a figure which was complete, on the blackboard the illustrative figure was built up line by line. Otherwise the presentation was the same except that the method varied.

**The Method of Teaching.**—The problem was assigned as a lesson. No explanation concerning it was given other than that the problem was important and required careful study. Opportunity was given for students to ask questions and to clear up any doubtful points. After sufficient time had elapsed an examination on this problem was given. As in the first examination, some students failed, a much smaller proportion of the class, however. These were coached and given further opportunity to master the principle, then a second examination was given to all students. This same process was repeated until a total of three examinations had been given.

**The Result.**—The curve, Fig. 2, is the exact record of what happened in one class. It will be observed at once that those students who could master this problem demonstrated this fact on the first trial, and that those students who could not pass the first examination never succeeded in mastering the principle. Other groups of students were tested in a similar manner with similar results. While the curve in Fig. 2 is the exact record of one group it is also a typical record of class performance under this system of instruction.

**Conclusions.**—The conclusion to be reached from these two experiments is so obvious as to require no exploitation. Briefly stated it is this: the method of presenting facts to students by the lecture system is inferior to the method of presenting facts by the text-book system.

Students are not capable of taking notes, are not able to remember demonstrations without notes, and are not developed mentally to the point of being able to assimilate facts at one hearing.

Given a text in which the matter to be learned is clearly stated, students will devote sufficient time to the study of these facts to overcome their individual handicaps in rates of learning. The proof of this is shown in Fig. 2.

After sufficient time for study, a class will demonstrate, if taught by the text-book method, in one trial that they have mastered the lesson. It requires from three to five trials to reach the same state of class perfection when the instruction is by the lecture method.

**Ontario Preparing to Construct 5,000 Miles of Improved Roads.**—A [illegible] road construction program is proposed by the Province of Ontario as a means of furnishing employment to soldiers returning after the war.

# Notes On Highway Design

By J. L. HARRISON

**Railroad Crossings.**—Many fatal accidents occur at railroad crossings. Most of these are admittedly due to the needless carelessness of the public, but this very fact should be sufficient to prompt engineers to avoid the selection of routes on which there are dangerous grade crossings. The [illegible] either over or under the railroad tracks in order to relieve the risk which, in many cases, could be more really and more economically eliminated by changes of route.

**Aesthetic Considerations.**—Aesthetic considerations are of great importance in the selection of the routes of modern highways. Such considerations are naturally of more interest to those who travel for pleasure than they are to those who travel for business. It is perfectly natural, therefore, that such considerations should play a more important part in the selection of a route for a modern highway than they have played in the past, for the increased amount of recreation travel which has accompanied the development of the automobile, has made both the attractiveness of the road and its immediate surroundings as well as the scenery which can be viewed from it, important considerations. As a feature in the selection of a highway route it should always be remembered that long tangents are an abomination. Few things will detract from the pleasure of an afternoon's drive more than the necessity of traveling for mile after mile on one straight line. Other conditions may make straight lines advisable, but from the standpoint of aesthetics that route should be selected which winds most gracefully along the river or through the hills, and from which there are to be seen here and there those country side views which so delight or those glimpses of the vastness of nature which so inspire.

**Technical Points.**—Beside these matters which are social in their general bearing there are certain considerations of purely technical nature which must also be examined. Among these may be mentioned such items as stream crossings, drainage, soils, the accessibility of road building material, etc. The selection of a highway route should, in all countenance, be begun by a careful examination of these features and the opinions arrived at concerning the technical feasibility of the various routes should be a matter of first consideration. However, for reasons stated in the article in Sept. 4 issue, this is not now the usual procedure and, in fact, it is hardly an overstatement of present conditions to say that these matters usually play no part in the selection of routes, being left for the engineer to struggle with after some one else has chosen the route which his road must follow. However, in the hope that a time may come when the purely technical considerations will play a larger part in the selection of highway routes, the following notes have been included.

**Stream Crossings.**—[illegible] wide. It therefore behooves an engineer to give the total length of the bridges which will be required on any route most careful consideration. The total length of structures required on the various routes will often be found to vary considerably, for even where the same streams must be crossed on all routes, it usually will be found that there are distinct differences in the width of the stream at different points. In fact, these differences are often very large. The writer has in mind a stream which he once investigated rather carefully and over which it had been planned to place a 400 ft. bridge, which was ample for the location that had been selected. For various reasons, largely political, it was desired that the crossing be made some 8 miles farther up the stream, but a careful reconnaissance failed to locate a single point within 2 miles of where a crossing was desired which could be made with less than [illegible] ft. of bridge. Another case of this same kind involved a comparatively small stream which, at the point where it crossed the established right-of-way, occupied a stream bed some six hundred feet wide. Within less than 1000 ft. of this point, this same stream could be crossed with one 160 ft. span.

Such cases are common and when coupled with the fact that there is a wide difference in the risk involved in bridging at different points along any stream, justify a careful examination of stream crossings. The difference which these matters make in the advisability of competing routes is, of course, largely a tangible difference which can be expressed in money value so is one which the laymen readily appreciate.

**Drainage.**—The general drainage of the country through which a road may run has an important bearing on the probable success of any construction which is undertaken. It is so customary to demand good drainage that few men stop to think farther than that the run-off should be prompt and complete. It is true that a good run-off is very desirable, but there are other considerations of equal or greater importance. One of these is that flat land always makes a poor location for a highway, for no matter how well drained it may be during the warm months, melting snow is very apt to so saturate the top layer or any large flat area that its stability is largely lost during the period when the snow on the surface is melting, but when the frost still remains in the ground to such an extent that it prevents the water on the surface from percolating into the lower ground strata. Moreover, there is apt to be a great variation in the water content of the soil in low flat areas. This is due to the fact that the rainfall onto and the flow of ground water into such areas is variable. At times the flow into these areas exceeds the flow from such areas. At times they are less than the flow from such areas. The level of the ground water is thus constantly raised and lowered and may, at times, even rise to or above the surface of the ground. Such areas are an unstable foundation for highways and should be avoided, for even expensive construction will not counteract the defect of a weak, wet subgrade.

Side hill locations are usually much superior to valley locations; that is, the drainage there is usually better. This can be carried still farther and, with equal truth, it may be asserted that a location along the top of a ridge is better than a location on either a side hill or in a valley, because here the possibility of trouble with water, whether from slow run-off, the saturation of the subgrade by a rise in the water table, or by reason of the failure of the ordinary means of sub-drainage when the ground is frozen is a minimum. Hill top routes of course present other difficulties which tend to offset this advantage, but the advantage here mentioned is one which could be made more of and which must be taken into more consideration if the loadings permitted on the highways are to be farther increased.

Hillside and valley routes are sometimes rendered inadvantageous by the presence of springs. However, springs usually have only a local effect and therefore can be rather easily controlled, so the presence of springs on any route, while annoying, may not be of much importance. The important matters are the elevation of the water table, the effect of capillary action, and the effect of snow and frost, all of which, while perhaps less easily discernible, are really of far more importance for, as yet, they are practically uncontrollable.

**Soil.**—The question of drainage is never far separated from the question of soil. Soils are so variable in composition and characteristics and the characteristics of soils vary with such utter disregard for what it would seem to be natural to expect from a determination of their composition that no very definite laws as to their value in subgrades can be laid down. However, it may be said, in general, that coarse soils make good foundations for roads and that a route running over such soils has an advantage over a route running over such fine soils as the clay, gumbos, etc. But, on the other hand, this is largely a matter of water content for a very small amount of water will make some coarse material soils, for instance as fine sand containing a moderate amount of slacking clay, extremely unstable, while on high ground even heavy blue clay and gumbo clay may serve very well indeed as a foundation material, if the rainfall is light and the slopes such that the run-off is rapid. This is extremely indefinite—but at that no more so than the subject warrants for there is practically no guide in this matter but experience, and even after years of careful observation soils will be encountered which, for one reason or another, fail entirely to perform as expected. Thus, some years ago, the writer examined a short stretch of road which had been built over a clay sub-grade. The road was a gravel road 8 in. thick and well built, a 10-ton roller having been used in compacting the subgrade and in placing the surfacing. The clay soil seemed normal in every respect and had, in fact, behaved in quite a customary manner during construction. In spite of this, the sub-grade absorbed so much water during three days of wet weather which came soon after this road was opened to traffic that the metalling was cut entirely through and on the fourth day traffic had to be stopped because the wheels were sinking to their hubs in the mud. That the sub-grade was the source of the trouble was clear, as the traffic was not heavy and the metalling similar to that used all over that region. This illustration is, perhaps, extreme, but it serves to show that while of great importance as affecting the life of a road too much emphasis should not be placed on soils as affecting the selection of routes for the simple reason that our knowledge of this matter does not yet warrant it.

**Road Building Material.**—During the regime of gravel and macadam roads it was considered advisable that roads should be located as near to natural sources of supply as possible. In a limited degree this is still advisable, but the limitations should be well understood and for modern high class improved roads, the less local stone used the better, unless the local stone, as rarely happens, is of very good quality. It used to be the idea that the proper location for a road was one which permitted the erection of a small crusher plant every few miles along the road within easy hauling distance of the road. This reduced the cost of metalling very materially, but the surface stone obtained from such workings was usually more or less decomposed and much softer than is now considered necessary, even for a macadam road.

For high class pavements, such as modern bituminous mixed tops, and for all concrete work, the use of local stone can only be looked on with favor when such stone can pass the most rigorous tests as to strength and general wearing qualities. It is such poor policy to try to save to from 50 cents a cubic yard by buying local stone for a concrete road if thereby 25 per cent of the possible strength of the pavement is to be lost, that the question of local supplies of sand and stone or gravel, except for roads of very secondary importance should not be considered. As a matter of fact, it should not even be necessary to mention so obvious a proposition, but the fact that one constantly sees cheap gravel, and soft stone used in high class paving work where a saving of a few cents a yard is made, at the expense of from a quarter to half of the strength of the pavement leaves the impression that this point needs constant emphasis.

**Canadian Contractors to Form National Association.**—A conference of contractors of Canada will be held at Ottawa, Ont., Oct. 22-24, for the purpose of organizing a national association of general contractors, sub-contractors and supply houses. At a preliminary conference last month a temporary executive committee, of which D. K. Trotter of the Montreal, Que., Builders' Exchange is Secretary, was appointed

**Openings for Mechanical Engineers.**—A limited number of mechanical engineers are wanted by A. H. Krom, Director of Engineering, 29 S. La Salle St., Chicago, Ill., for openings in essential industries and departments of the Government. Men must be 30 to 45 years of age and thoroughly familiar with shop and metal work.

# Effects of the War on Construction of Vermilion County Bond Roads

By P. C. McARDLE.

[illegible]

[illegible] divided, about the middle of May.

Only two of these contractors had had previously any extended highway experience, although all had done considerable municipal contract work and all were apparently financially able to carry their contracts to a successful conclusion within the contract time. That more of these contractors had not had any more experience, was to be expected because comparatively little of this class of work had been done in Illinois. As time went on, prices of labor and materials began to rise on account of the withdrawal of labor to the munition plants, etc.

The output of the work on the nine divisions in 1916 amounted to an average of but 5.6 miles per contract. This was further decreased in 1917 to an average of 4.4 miles per contract. Meantime war had been declared. Men were still more rapidly being withdrawn from industry for the prosecution of the war, and car service order No. 1 went into effect April 26, 1917, and Priority Order No. 2, on Oct. 28, 1917. These two orders effectually stopped work for at least two of the best working months of the year, resulting in the production of 92.43 miles of road out of a total of 166 miles contracted, within the time specified in the contract Nov. 1, 1917. County officials, well aware of the added costs of labor and materials incident to the war, hesitated to try to enforce the forfeiture terms of the contract for non-completion and relet or to try to enforce penalties for such non-completion because of the defense which might be raised by the contractor and his bondsmen, that war automatically prevented the successful execution of the work. All were notified, however, that the county expected them to complete the work at the earliest possible moment.

The spring of 1918 witnessed but two contracts under way. Jan. 1 saw the railroads of the country taken over as a war measure by the President of the United States and there followed rigorous rules regarding switch tracks and movements of freight and higher freight rates, which made more incumbance on the work as a result of which, the two remaining contractors withdrew from their work. The appeals of citizens, deeply interested as abutting property owners and others offered considerable inducements to the contractors to again take up the work and prosecute the contracts to a successful conclusion.

On one of these divisions, No. 6, committees were formed in each of four small towns through which the road passed and in a short time had obtained guarantees of sufficient free teams to haul all of the material on 5½ miles of road. On Division 8, without formation of any such committees, but on the request of one or two prominent farmers, sufficient teams were obtained to move the entire camp and appliances from Hastings to Jamaica, a distance of 11 miles, and they also agreed that if the contractor would provide the shoulder material at the siding they on their part would haul it to the job free of cost to the contractor, provided he placed the concrete slab. In the case of moving the camp from Hastings to Jamaica, there was no pre-arranged plan. One farmer agreed to go out and obtain the necessary teams to move this camp and equipment in one day, and this was actually done. The second part of the agreement has not yet been carried out and will not be until the con[illegible]

[illegible]

[illegible] propositions worked out that farmers in other sections of the county in at least two other divisions, are at this moment gathering the necessary subscriptions to get work [illegible]

[illegible] farmers so interested, and the answer must be given, that they have had from one to two years' experience in driving over the roads already built and they are now endeavoring to close up the vacant links in the chain of r[illegible] matter what the season or whether in the day or night, they may travel comfortably between their homes in the country and the cities in which they have business. To do work by volunteer labor on the roads, is not new to Illinois, but it is decidedly new to find the public donate money and labor [illegible] perience has convinced even the most skeptical, that a good road is an absolute necessity and t[illegible] in the form of labor or money, in order to get the roads now rather than wait until after the war, when times become normal again. They have taken the attitude that this is not the time to blame any one, except "der Kaiser," but it is a time for every one to enthusiastically support any movement that will better our own home conditions even before the war is over.

# Field Test Results of Use of Hydrated Lime in Concrete Roads

There has been much conjecture during the past few years on the part of highway engineers as to the effect hydrated lime has on the strength of concrete when used for highway purposes. An investigation of the subject has been conducted by the State Highway Department of Delaware under actual field conditions. Test specimens were poured from batches of concrete that were being placed in the road, and were exposed to the same conditions of storage, to which the road was subjected. At the end of the 6 months period the specimens were removed to the laboratories of the Henry S. Spackmen Engineering Co., Philadelphia, for breaking under compression. The results were

[illegible]

In breaking under compression, it was noted by the laboratory that failure of the coarse aggregate occurred in every case.

The following paragraphs, extracted from a letter of [illegible]

[illegible] the same time the concrete was being placed upon the roadbed. A chute mixer was used. The cylinder form was filled by holding it under a chute and deflecting the flow of concrete from the road into the form. All specimens of one mixture were taken from the same batch in the mixer.

The specimens were not tamped, but were struck off on top and then were covered in order to protect them from the rays of the sun, this being identical with the treatment given the road. After being covered for 24 hours, they were buried at the side of the finished concrete road, and at the time when moist earth was thrown on the road the specimens were included under this covering. They were left in place until they were 6 months old and received the same treatment as the road during this period and were then taken to be broken.

As the tests were started in November, it will be seen that the specimens were subjected to the Fall, Winter and Spring periods.

Consistency of the mixture was determined by the inspector and the testing engineer in accordance with their ideas of an ideal working consistency. The amount of water was not measured as it was not practical under the circumstances, but the same consistency was maintained during the mixing by the agreement of opinions of the man running the mixer, the inspector and the testing engineer; that is, the specimens were poured when the consistency was unanimously agreed to by the three parties as being the same as that of the previously made specimens."

## Specifications for Roller and Belt Method of Finishing Concrete Roads

The following clauses regarding the finishing of the surface of concrete pavement form a part of the standard specifications of the State Division of Highways of Illinois, for concrete road construction:

> After the surface of the concrete pavement has been struck off to the proper cross-section, it shall be finished by rolling and belting. The roller and belt shall meet with the approval of the engineer.
>
> The belt shall be of canvas-rubber composition from one to four ply, and shall have a width of 6 to 10 in., and a length at least 2 ft. longer than the width of the pavement. Preferably two belts of different weights should be used, the lighter one being used for the last belting.
>
> The roller shall be of smooth steel from 8 in. to 12 in. in diameter and shall have a total length of at least 4 ft., but preferably 6 ft. The weight shall not exceed ¾ lb. per inch of length of a roller 8 in. in diameter, nor 1 lb. for one 12 in. For roads not more than 15 ft. in width, the roller may be operated by a handle so designed and used as to neither increase nor decrease the pressure coming upon the concrete from the roller. For roads of greater width, the roller should preferably be operated by ropes.
>
> Immediately after the surface of the concrete pavement has been struck off with a template, it shall be belted over once with a combined crosswise and longitudinal motion, using long, vigorous strokes of the belt. At this belting the longitudinal motion shall be slight, but it may be increased in succeeding beltings. Care shall be taken not to work the crown out of the pavement, nor to permit the edges of the belt to dig into the surface of the concrete.
>
> After an interval of 10 to 20 minutes, or as much longer as the engineer directs, the roller shall be slowly operated transversely from one edge of the pavement to the other, and then back again over the same area. A one-half lap shall then be made and the rolling continued as before until the entire surface has been rolled. In moving the roller to make the lap, great care shall be taken not to mar the concrete.
>
> Immediately after the rolling, the surface shall be belted a second time, and about 15 minutes later, or as the engineer directs, it shall be rolled as before.
>
> Just before the concrete obtains its initial set, the surface shall be given a finish by a final belting in order to produce a uniform surface of gritty texture. This belting shall be of short, rapid, transverse strokes having a sweeping longitudinal motion.
>
> The use of a short handled wooden float as a substitute for the belt will be permitted only by the written authorization of the engineer. If such permission is granted, the finishing shall be carried on from a suitable bridge, no part of which shall come in contact with the concrete. The use of a long-handled wooden float is specifically prohibited.
>
> The edges of the pavement shall be carefully finished with an edger of about 1 in. radius.

## Drainage Increasingly Vital with Growth of Heavy Traffic*

**By E. W. JAMES,**

General Inspector, U. S. Bureau of Public Roads.

When the recent failure in several States of a considerable mileage of first-class road is considered, it appears that the problem of the immediate future is going to be the development of adequate foundations to handle a fast-growing motor-truck traffic.

Whether the increase in number of trucks in the next decade will in any way approximate the increase in pleasure automobiles during the last one is not a matter of special moment, but it is of the greatest importance whether the gross tonnage of trucks increases rapidly. A single truck of some designs will provide a tonnage equal to five or six touring cars. A single truck operating between fixed termini has damaged a road in a single month to more than the ordinary cost of maintenance for a whole year. A string of trucks operating over a road not properly supported by the existing foundation has entirely destroyed in two weeks a well-built surface costing $8,000 per mile.

**Weak Foundations Prolific Cause of Failures.**—Careful inspection indicates that failures have largely been the result of weak foundations at the time frost is "coming out of the ground," when the water content of the soil is high and foundations are consequently weakened. What degree of weakening is permissible under any conditions before failure is reasonably certain is not known because we never know even approximately the factor of safety in the bearing power of our sub-base or subgrade. The few studies made in this direction have little application to road conditions, because the moisture content of the soil and its grading or texture, which so strongly affect capillarity, have never been adequately considered. Further, it is doubtful if within the immediate future any increase of knowledge of soil conditions will be sufficient to indicate a method of direct control. Capillarity can not be adequately controlled. It must be met.

**Soil Moisture and Its Effects on Sub-Grades.**—The same degree of approximation in our road foundation design will doubtless prevail until considerably more data are available regarding soil moisture and its effects. In the meantime such information as we have can be used for what it is worth. Some recent examinations made by an engineer of the Bureau of Public Roads furnish the following interesting data:

Clay below a concrete pavement contained 18.88 per cent by weight, or about 46 per cent by volume, of water. In another case clay contained 12.7 per cent by weight; in still another case, 12.23 per cent. Clay loam under an asphalt pavement on a 7-in. concrete base contained 13.58 per cent by weight, or about 33 per cent by volume, of water.

Sand cushions under grouted brick and on a concrete base have been found to contain 6.38 per cent of water by weight; and under a tar-filled brick pavement and on a concrete base 9.05 to 13.76 per cent. Under wood block on a concrete base the sand cushion may contain as high as 12.7 per cent of water by weight.

**Studies of Capillary Action.**—These figures may be considered as being the natural moisture content of the various materials under the conditions existing. In every case the structures were first class and believed to be adequately drained.

Some extended studies of the action of capillarity conducted by the Irrigation Division of the Bureau have furnished additional interesting data.

The following table shows the height to which capillary water rises in certain soils in 24 hours:

| | Inches. |
|---|---|
| Light sandy soil | 14 |
| Gravelly soil | 16 |
| Decomposed granite (loam) | 21 |
| Heavy granite loam | 16 |

---

*From Public Roads, Official Publication of U. S. Bureau of Public Roads.

| | |
|---|---|
| Heavy clay loam | 31 |
| Heavy sandy loam | 4 |
| Pure sand | 1 |

In one day the capillary water moves upward about one-half its apparent final limit. In three days it moves about two-thirds its apparent final limit. In some soils the movement upward in the first two hours is as high as one-third of the movement for 30 days. In pure sand it rises in one-half hour approximately one-half as high as in one day and in one day about 75 per cent as high as in 12 days.

The movement is more rapid at the start in light soils and slows down rapidly. After three days the movement is exceedingly slow in pure sand. In heavy soils the movement is uniformly slower and more sustained.

In light soils the per cent of water in the soil decreases rapidly with the height above the source of water, while in some heavy soils the water content is strikingly uniform at different depths.

Horizontal capillarity occurs with much faster water movement and greater uniformity of moisture content. The speed and distance varies with different soils and ranges from 7 to 11 ft. in the first 24 hours.

**Source of Free Water Must Be Removed.**—An examination of the above figures indicates that capillarity in some cases fills the soil perilously near to the saturation point even when drainage is considered adequate. And the rapidity with which capillary action occurs when there is a source of free water makes it imperative that such source be removed with the greatest promptness and prevented from occurring within a considerable distance, either vertically or horizontally, from soils which are depended upon to support heavy loads.

The action of capillarity indicates that if water is to stand or flow along a road embankment for even a few hours, regard must be given to the height of the subgrade above the water line, and the lateral distance of the watercourse from the road surface.

Assuming that the supply of free water will not endure more than one day at a time, it is apparent that a height of 18 in. in the subgrade above the water line will insure that the moisture content near the surface is not increased. Where the free water is present at a considerable distance to one side this height may safely be reduced. Shallow ditches a short distance from the center line tend, by horizontal capillarity, to increase the water content of the subgrade at a higher level than deep ditches similarly located. If the grade is through standing water or against a continuous source of free water so that the soil remains continuously moist, capillarity will lift the water about 4.5 times higher than in dry soil, and this fact must be considered in designing cross section and grade across swamps, marshes, or against irrigation or drainage ditches in which water is present for long periods.

**Where Special Drainage Is Needed.**—These conditions affect the design of cross section and the establishing of grade in places where the presence of free water is foreseen or where run-off is expected to be slow and considerable, if the full bearing power of the natural soil is to be developed. If the design of cross section can not, because of immediate local conditions, be made to meet the above requirements, then special drainage should be provided or additional bearing value given by some suitable treatment.

The writer recalls a specific case in Florida where a light sand and sandy loam were reinforced by a 4-in. layer of natural sand-clay preparatory to placing wearing surface. The cementing value of the sand-clay mixture was counted upon in the design to furnish a nonflowing base adequate to distribute the comparatively light loads probably to come upon the surface. Wherever the road was located on a ridge or high well-drained natural soil, this base appeared adequate; but where a grade was thrown up across marsh land, swamps, or near standing water in the "flat woods," the elevation above prevailing water level was so little that even when the clay base appeared dry and satisfactory just as soon as [illegible] at the surface of the clay thereby reduced, the clay became sufficiently moistened from the subgrade, by water supplied by capillarity, for the bond of the clay to yield and the base to become more or less plastic and flowing.

Experience alone has developed many of the features of our present highway cross-section designs. Certain bearing powers of the soil are more or less conservatively assumed as we follow accustomed practice. Now that the [illegible] it is a problem of the utmost importance to determine how much heavier our foundations must be, just what loads soils with different moisture contents may be depended upon to bear, and what means if any, can be developed to insure no increase of moisture above a safe point. Of course, these problems are closely correlated. How does moisture content affect the bearing power of soils? And ultimately what method of design will be most economical? Will it be cheaper in a given condition to drain excessively or to thicken the foundation? These matters are today a closed book to the highway engineer.

Finally, we must face the natural law at work through capillarity and realize that it can not be removed. It must be met.

**More Extensive Drainage Required for Cheap Roads.**—In matters of practice we shall find little to encourage the builder of cheap roads. Tile drains, French drains, the various types of subbase will doubtless have to be used much more extensively in some sections than they have ever been. Grades will have to be kept higher in flat locations and, to retain the general crescent design of the crown and thus avoid deep cut ditches, construction lines will be much wider than customary. This will have its effect on width of right of way.

**Design of Short Sections of Road a Local Problem.**—In a few states where systematic road construction and maintenance have required the development of an adequate permanent organization of engineers, road builders, and maintenance forces, experience has resulted in producing a practice that more and more completely meets the conditions that in the past have caused failure of our roads under increasing traffic or imperfect drainage features. This practice is to consider the design of short sections of road as a local problem. Frequently the cross-section design is changed several times in a mile, gravel base, sand, crushed rock, telford, V-drain, or stone base is placed where needed to meet the local drainage and soil conditions. To be sure, much of this work has been done as betterment or maintenance, subsequent to the original construction. Each spring certain bad locations have been torn up and repaired by providing the necessary drainage or foundation. As engineers will in general realize, some of these failures are due to conditions that were not apparent at any time during the preliminary survey and investigation, and appear to have developed after construction. But the greater part of such repairs are to meet conditions that could have been ascertained by proper preliminary investigation and adequate engineering design preceding original construction.

In a great majority of highway plans, however, will be found a single cross-section design, expected to be adequate to meet conditions mile after mile, through cut and fill, uphill and down.

**Former Special Features Will Become Part of Regular Design.**—Under the increasing truck traffic, drainage will have to be considered more carefully, moisture content of many soils in many locations considered allowable under past conditions will have to be reduced to save or develop such bearing value as the soil may have, and a great deal of moisture must [illegible] to be overcome by the addition of suitable subbase. All of these details, considered heretofore as special features, will become the features ordinarily considered in careful design of high-class costly pavements. A foundation and wearing course costing $16,000 per mile are not going to be subjected to what is now known to be an utterly destructive traffic without that due examination of soil conditions and adequate provision for furnishing a proper support in the natural ground that will save the surface and foundation from destruction at a reasonable cost.

Within a few months there has appeared an article in one of the engineering journals in which the writer said that the day of open stone bases was past; that telford, field stone, V-drain, etc., were no more dependable than a firm, well-compacted earth subgrade. This statement in the light of the traffic which has developed in the last six months becomes daily more and more surprising. An earth subgrade can be kept dry only when capillarity is destroyed or its range in distance exceeded, and for most cases the latter possibility is not within the reach of road designs. The writer is more and more convinced that the older types of large stone foundation, with large interstices, included the principles which will be found of greatest effect in resisting the failure of subgrade bearing because of excessive soil moisture. This opinion is strengthened by a consideration of frost action, especially in the spring, when alternate freezing and thawing may be expected.

**Design of V-Drains.**—It has been the custom in recent years in the limestone sections of Tennessee and Kentucky, when it became necessary to rebuild some of the old "pikes," to salvage the telford, crush it, and place it back as macadam. In one case, at least, this was done on first-class engineering advice, and in this case the result was not satisfactory. The reason for failure appears to have been due to insufficient drainage of the base, which had been provided for years by the old telford and was most carefully closed by the new construction. The result of this condition is greatly emphasized by severe frosts.

Some designs for V-drain, in order to save stone, require that the drain be carried out practically to 0 depth at the extreme edges, so that the stone or other road metal is practically without drainage at those points.

In northern localities difficulty has been experienced when V-drains of this design have been used with the edges of the road crust heaving in the spring. This is probably due to the freezing of accumulated water near the edges of the drain. Such water will accumulate in the interstices as a result of shallow thaws, which do not free the deeper areas of frost. The melted snow can not run off and fills the upper layers of the V-drain, especially near the edges, until the voids are too full to allow expansion on freezing. The result is that during succeeding freezes the edges of such drains will heave. The remedy is to increase the depth of V-drain at the edge and to provide drainage close to the surface through the shoulder, so that such drains will certainly clear with the shallow thaws and permit water to flow freely from the V-drain. Experience indicates that the depth of V-drain, in addition to the surfacing material, should not be less than 4 in. at the edges and that a depth of 6 or 8 in. is better.

**Outlets Should Be Provided.**—Outlets for conducting water away from the V-drain should be provided at all low points in the grade. These outlets may consist of tile running from the lowest point of the V to a culvert or cross-drain, or of ditches filled with the same kind of material as that composing the V-drain and running from the lowest point in the V to any lower point outside of the road where they may empty.

The error has often been made of depending on tile or French drain to remove the excessive and damaging moisture from soils that do not readily give up their contained water. While tile drains for agricultural purposes may in the same soils be entirely satisfactory, because rapidity of action is not essential, they are not adequate for road drainage.

When road construction is approached in the spirit necessary to meet the conditions cited here, the result will be a series of cross-section designs, instead of a single design to meet all conditions, much more general use of subbase and tile drainage, more careful consideration of the material of the subgrade, and the methods used in finishing it. To do these things intelligently, there will have to be undertaken by some one extensive studies of existing conditions. These are matters about which much may be learned by a close and studied observation of failure.

# Standardization of Screen Openings in Production of Broken Stone for Road Purposes

During the summer of 1917 engineers of the U. S. Bureau of Public Roads made a survey of stone quarries in certain sections of the country with the primary object of obtaining data relating to the commercial sizes of broken stone, which would enable the Bureau to recommend a minimum number of standard sizes necessary for the various types of roads in which broken stone is used. It was found that, within a very restricted area, revolving screens, with as many as 28 different size openings, were being used to produce stone for a comparatively few types of roads. As a rule, the exact size of product for any one type of road is selected by the individual engineer without reference to other products which the crushing plant may be called upon to supply, also without reference to what size or sizes the engineer himself will select for other types of roads. Moreover, great lack of uniformity in the method of specifying sizes of broken stone was found to exist so that the entire subject of broken stone specifications is at present in an almost chaotic condition.

In a bulletin, "Typical Specifications for Non-Bituminous Materials, prepared by Prevost Hubbard, Chemical Engineer, and Frank H. Jackson, Jr., Testing Engineer, issued recently by the U. S. Bureau of Public Roads, the specifications for sizes of broken stone are based upon laboratory screen tests, rather than upon the size of openings in the commercial screen which produces the material. Based upon data secured in the survey mentioned above a limited number of sizes also has been selected. It is believed, states the Bulletin, that for the commercial production of each size sufficient tolerance has been allowed in the specifications to make practicable the use of revolving screens with the same openings as the maximum and minimum laboratory screens specified for that size. In most cases, the amount passing an intermediate laboratory screen has also been specified with limits (from 25 to 75 per cent) sufficiently wide to include all acceptable commercial products between the maximum and minimum size but reject most products which would be unacceptable.

The different size broken stone products which may be used satisfactorily in constructing various types of road are given in Table I. It will be seen that not more than five different size openings in revolving screens are required for any one type. In order to meet reasonable working conditions, a general tolerance of not less than 5 per cent

TABLE I — RELATION OF COMMERCIAL REVOLVING SCREENS TO LABORATORY SCREEN REQUIREMENTS FOR BROKEN STONE.

| Type of road. | Revolving screens | | | | |
|---|---|---|---|---|---|
| | 3-in. | 2-in. | 1-in. | ½-in. | ¼-in. |
| | Per cent passing laboratory screen of same size. | | | | |
| Water-bound: | | | | | |
| Bottom course | 95+ | 15— | .... | .... | .... |
| Top course | .... | 95+ | 15— | .... | .... |
| Screenings | .... | .... | 95+ | —— | 40-80 |
| or | | | | | |
| Base or both courses | 95+ | .... | 15— | .... | .... |
| Screenings | .... | .... | 95+ | .... | 40-80 |
| Cover for bituminous surface treatment: | | | | | |
| Coarse chips | .... | .... | 95+ | .... | 15— |
| or | | | | | |
| Fine chips | .... | .... | .... | 85+ | 15— |
| Bituminous macadam: | | | | | |
| Bottom course | 95+ | 15— | .... | .... | .... |
| Top course | .... | 95+ | 15— | .... | .... |
| Chips | .... | .... | 95+ | .... | 15— |
| Screenings | .... | .... | 95+ | .... | 40-80 |
| Bituminous macadam: | | | | | |
| Wearing course | .... | 95+ | 15— | .... | .... |
| Chips | .... | .... | 95+ | .... | 15— |
| Bituminous concrete: | | | | | |
| One-size stone | .... | .... | 95+ | .... | 15— |
| Chips | .... | .... | .... | 95+ | 15— |
| Graded bituminous concrete: | | | | | |
| Coarse aggregate | .... | .... | 95+ | .... | 15— |
| Chips | .... | .... | .... | 95+ | 15— |
| Bituminous concrete (Topeka): | | | | | |
| Broken stone | .... | .... | .... | 95+ | 80— |
| Sheet asphalt: | | | | | |
| Binder stone | .... | .... | 95+ | .... | .... |
| Cement concrete pavement: | | | | | |
| Coarse aggregate | .... | 95+ | .... | .... | 15— |
| Cement concrete base: | | | | | |
| Coarse aggregate | 95+ | .... | .... | .... | 15— |

retained on the maximum screen, and 15 per cent passing the minimum screen has been allowed. In the case of screenings, where only the maximum size screen would be required ordinarily, as the product would include dust and all other smaller material, from 85 to 95 per cent of material passing the ¼ in. screen is specified. The only other exception is the broken stone for [illegible] concrete, where at least 95 per cent of material is required to be retained on the ¼ in. screen.

It is realized that just as satisfactory roads may be constructed with sizes of broken stone varying considerably from these specifications. It is believed, however, that the sizes here covered represent average practice and they are recommended for general use as a means toward standardization [illegible] plant practice in the production of broken stone for highway work.

# State Highway Departments to File Road and Street Programs for 1919 by December 10

Programs for next year's road and street work must be submitted to the United States Highways Council by the State Highway Departments by Dec. 10. Instructions and forms for compiling this injunction were sent out Sept. 20 by the Council. The policy of the Council with reference to highway and street work during the war was detailed in Bulletin No. 1 an abstract of which appeared in the Sept. 4 issue of Engineering and Contracting. The Council, however, has recently passed a minute which we quote from the instructions to the State Highway officials as follows:

"In submitting a program for next year's work, the state highway department should confine its recommendations to the maintenance of such roads as contribute to the winning of the war. Only the roads most urgently needing construction or reconstruction should be recommended, as the necessity of the war program is likely to preclude the possibility of such work going on."

The form (H. C. 4 reproduced below) sent to the State Departments is in the nature of a summary of the money, materials, labor and transportation required for each class of work. A separate set of schedules is to be submitted for state, county, township and municipal work respectively, thus making four sets of schedules. Each of these classes is to be divided into: Construction, reconstruction and maintenance, respectively. The council requests that a fourth class be added, to be known as resurfacing. The net result will be the submission of sixteen schedules: Four for state work, four for county work, four for township work, and four for municipal work, if each class involves construction, reconstruction, resurfacing, and maintenance.

Form HC-4 is not designed for sending out to subdivisions of the state, but is in the nature of a summary of the returns made by the counties, townships and municipalities to the state highway department. In order to obtain the information from the subdivisions of the state, it will be necessary for the Highway Departments to send out a suitable form.

[illegible] that so far as practicable that the State Highway officials indicate on a state map the locations of the proposed improvements [illegible] selection. It is understood, of course, that [illegible] authorization or financial ar[illegible] in as representing [illegible] case the projects meet with favor.

[illegible] ticable to show its location on a state map and in such cases if a city map is available it would be desirable if the city map and a schedule similar to the one above described could be submitted. These maps and schedules, together with the forms HC-4 summarizing the needs of the state, counties, cities, and townships would afford the Council much useful information in outlining policies for next year.

# Reserving and Planting Roadside Trees

The following notes on roadside trees are abstracted from an address delivered at the 5th Road Institute at the University of North Carolina, by J. S. Holmes, State Forester of North Carolina:

There are two ways of securing roadside trees: reserving and planting. Instead of cutting down all the brush and young growth along the sides of the road, here and there thrifty young trees of suitable species can be reserved for future shade trees. In making such reservation, suitable kinds and properly shaped thrifty individuals should be selected. Most of the oaks, ashes, and elms make good roadside trees, as do also the beech, hackberry, linn, sycamore, sweet-gum, sugar maple, and yellow poplar. Such nut trees as black walnut, pecan, and shellbark hickory make beautiful as well as very useful shade trees. Conifers and other evergreen trees are not generally recommended for roadside trees, because the winter sun is wanted on nearly all roads.

The position of the trees must also be taken into consideration. It is usually better to have them well back from the edge of the road, especially if nut trees are used, and not too near together. From 40 to 60 ft. apart is close enough for larger native trees. The tops of these trees should never be cut back, but the lower branches may be trimmed off; they may be thus encouraged to branch well above the line of vision of the traveler.

In planting roadside trees a greater selection of species and position is possible. Some trees of foreign origin have points of advantage and may be used in certain cases. The ginkgo and larch are taper pointed and tend to throw shade only immediately under them; while the lombardy poplar with its perpendicular branches makes almost no shade at all, and yet very pleasantly breaks the monotony of a level landscape.

Division 1 $170,000

Stone .. 32,500 T

Asphalt .. 900 T Imp

STATE HIGHWAY DEPARTMENT [illegible]

Purely ornamental trees can be reserved or planted in many places to advantage, especially along straight reaches of road where they will not interfere with seeing across corners or curves. Dogwood and sourwood are our most ornamental roadside trees, and can be found for reservation almost everywhere, while crab apple and wild cherry are desirable where the tent caterpillars can be kept out of them. In addition to these, the crape myrtle and many of our larger shrubs should be much more extensively planted for beautifying our roadsides.

In planting native trees, wild stock can usually be secured. Small trees are more likely to succeed than large ones; trees 6 to 10 ft. high and 1 to 2 ins. in diameter are a good size for this purpose. Plants growing in the open are usually thriftier and of a better shape than those in the shade of the woods, and should be selected. Top-pruning is rarely advisable, but the side twigs should be cut back to balance the unavoidable root pruning.

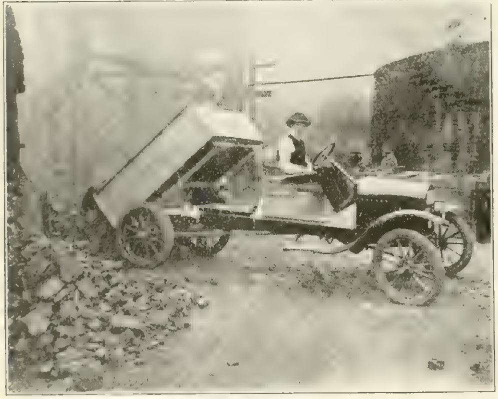
Planted trees should be protected from stray stock and children by stakes or, by what is still better, a guard made of cross slats nailed onto stakes. They should be thoroughly watered two or three times during the driest seasons through the following summer. No subsequent pruning will be necessary for many years unless the branches become broken by sleet, wind, or other accident.

The greatest menace to roadside trees is from telephone, telegraph and transmission lines. In many States they are protected by law from mutilation by such corporations.

Roadside trees, like those in the forest, orchard, or park, should be protected from fire and insects. Brush should be burned at a safe distance from them, and only when there is no danger of the fire spreading. Tent caterpillars are the most destructive and unsightly insects. With a little trouble they can be pulled out and killed in a bucket part full of water, with a little kerosene on the top, or the webs can be burned in the tree.

## Automatic Dump Body for Small Trucks

An automatic dump body designed for attachment to a Ford 1-ton truck is shown in the accompanying illustration. The dumping is accomplished simply by releasing the latch, the body being instantly restored to the horizontal position upon disposal o fthe load. This accomplished by the use of cams on inverted V-shaped racks, which are fastened to the chassis by bolts passing through the standard holes in the rear cross member of the chassis. At the front they are located on brackets which are in turn fastened to chassis frame by means of U-bolts. The eccentric load devolving upon these brackets is taken care of by means of a rod which fastens both brackets together at points above the frame. In this manner all the strain of eccentric loading is relieved from the attaching U-bolts. It is possible to arrest the body movement at any angle and hold it there. In the same manner also may the body be so retarded that the final dump is accomplished easily and without excessive strain to any of the parts. In connection with this feature road material, such as crushed rock, gravel, cinders, etc., can be spread by holding the body at the proper angle and opening the tail gate at that point. A device attachable to the tail gate can limit this opening so that only a certain thickness of material will pass out the gate. The body is manufactured by the Anthony Co., Inc., Streator, Ill.

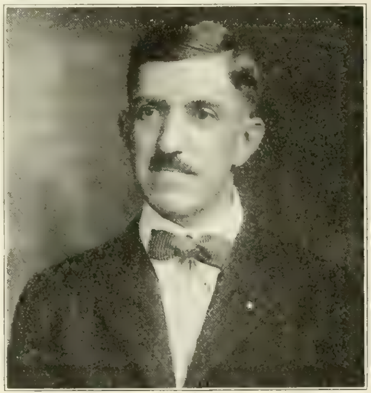


Automatic Dump Body Attached to 1-Ton Truck.

## Industrial Notes

### Links Up With Lakewood.

Payne G. West has been appointed assistant manager of field sales for the Lakewood Engineering Co., Cleveland. Mr. West is a graduate of Carroll College, class of 1901. He later studied civil engineering for two years at the University of Wisconsin. In 1907 he became associated with The T. L. Smith Co. of Milwaukee. During eleven years with this firm—most of which he was assistant sales manager—Mr. West thoroughly familiarized himself with all branches of the machinery field as well as with factory production methods.



Payne G. West.

## Personals

Bart Moore of the McCall-Moore Engineering Co., Waco, Texas, has entered the engineering corps of the Army.

Edgar M. Hoopes, Jr., formerly city engineer of Wilmington, Del., has been commissioned captain in a Quartermasters Corps, U. S. A.

J. F. Witt, county engineer of Dallas County, Dallas, Texas, has been appointed regional chairman of the National Highways Transport Committee.

W. H. Johnson, formerly engineer of the California State Highway Commission, has been commissioned as a first lieutenant in the Engineers Corps, U. S. A.

Maj. Joseph W. Shirley, chief engineer of the Topographical Survey Division of Baltimore, Md., has been appointed chairman of the Annex Planning Commission of this city.

Frank L. Bennett, Commissioner of Public Works of Chicago, has been appointed director of the State Department of Public Works, to succeed the late Judge Leslie D. Puterbaugh.

Paul Sullivan, assistant city engineer of Cincinnati, Ohio, in charge of the Street and Sewer Repair District Division, has been commissioned a first lieutenant in the Engineer Corps.

William P. Danford, assistant state engineer with the State of Oklahoma, has received a commission as first lieutenant in the Engineers Corps and reported at Camp Humphreys, Va., on Sept. 18.

Due to the fact that both Maj. G. R. Solomon and P. H. Norcross are in Washington on war work, the Atlanta, Ga., offices of the Solomon-Norcross Co., Consulting Engineers, will be closed for the duration of the war.

C. A. Dykstra, formerly of Ohio State University, has resigned as head of the political science department of the University of Kansas to become head of the Civic League of Cleveland. He will succeed Mayo Fesler, who takes charge of the Brooklyn Chamber of Commerce.

A. C. McKibbin, who has served as secretary of the State Highway Board, of Missouri, since its organization in March, 1917, retires as secretary on Sept. 20. He retains his position as a member of the State Highway Board, having been appointed by Governor Gardner for a term of 4 years. Mr. McKibbin will devote practically all his time to the development of the Highways Transport Committee of the Missouri Council of Defense, and the Capital Highways Association which is working for the improvement of a system of roads radiating from the state capital. Offices for the organization have been opened in the Central Trust Building, Jefferson City, Mo.

*Waterworks and Hydraulics Monthly Issue*

**ENGINEERING *AND* CONTRACTING**

Volume L. CHICAGO, ILL., OCTOBER 9, 1918 Number 15.

[illegible]

Roads and Streets—1st Wednesday
[illegible]
Waterworks and Hydraulics—2nd Wednesday
[illegible]
Railways and Gov't Works—3rd Wednesday
[illegible]
Buildings and Structures—4th Wednesday
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[illegible] Publishing Co.

CONTENTS

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# The Opposition of Certain Labor Unions to Women Workers; How Can It Be Overcome?

[illegible] jobs because "The investigators found that the labor situ[illegible] women because of the shortage of man power." This is a sample of the Government inconsistency in labor matters that has irritated thinking men ever since the war created an abnormal demand for labor. Now, everyone knows that the real "because" in the "reason" for discharging the 200 women conductors was not the "because" given by the Federal labor investigators, Henry B. Dielmann and Miss Margaret Russanowska. The real "because" was the threat of 2,500 men conductors to strike unless the women conductors were "canned."

Suppose it actually were a fact that there is no shortage of manpower in Cleveland. What has that to do with the problem, anyway? The real question is whether there is a shortage of manpower on the farms, in the factories and mills, on construction work—not in Cleveland but anywhere in America.

If the Federal Government can not send better labor [illegible] to have a shortage of manpower although there is no necessity for it. We shall soon have 5,000,000 men under arms. There are twice that number of women available [illegible] has been shown that most of the positions held by men [illegible] per cent of the employes in Government establishments, not including controlled establishments engaged in munitions works, are women, and the percentage is steadily rising.

Charles U. Carpenter, Vice-President of the Recording and Computing Machine Co., states that 5,000 of his company's 8,600 employes are women. Practically all the mechanical operations and assembling are performed by women. He says:

> [illegible]

With proper teaching there is apparently nothing that women can not do, except where great physical strength and endurance are required, and they often excel the men they have replaced.

The war has taught women a lesson they will never forget, and many of them will hereafter refuse to live up to the man-made ideal expressed in the old maxim that "a woman's place is in the home." Labor unions have always opposed the entry of women into occupations re[illegible] entire productivity of all workers, properly distributed. The output of 5,000,000 additional women workers will constitute no menace to the 5,000,000 soldiers upon their return from the war, provided steps are taken to secure new work for them. So long as a large part of mankind still longs for luxuries not yet available, just so long will there be fields open for more workers.

Consider, for a moment, what is still desired by Americans: Better clothes, better homes, larger and better playgrounds for adults as well as for children, better roads and streets, better public buildings, better education, etc.,

etc.—and more leisure for recreation and enjoyment. Now all this, even to the added leisure hours, is to be purchased in but one way, namely, by the larger hourly productivity of our people. We say "hourly," rather than "daily," in order to emphasize our ultimate aim, namely, a shorter working day. It is feasible to do in 6 hours what now requires 8 for the average worker and without any great increase in the investment in plant and tools. Every man experienced in applying the science of management has proved this fact again and again. Mr. Carpenter, who was quoted above, joins in the unanimous verdict of scientific managers, when he says:

> The production man can soon learn that in the average shop the actual output can, by simple, common, horse sense methods, be increased from 30 to 50 per cent and surely such results are enough worth while to justify careful study and developments of method.

Standing in the way of progress we find, not only general ignorance, but a special kind of ignorance as well, namely, the ignorance of many labor union men who oppose the employment of women on the ground that the women are depriving men of a means of livelihood. The obvious remedy for this social ill is education in the principles of political economy. It devolves upon all engineers and other men trained in economics to spend a portion of their time in dispelling economic illusions, which, ghost-like haunt the paths of progress and frighten the uneducated masses.

# An Annual Ignorance Tax of a Quarter of a Billion Dollars on Fuel Alone; What Should Engineers Do to Eliminate It?

Not long ago the writer was in a large bank building that was illuminated with old-fashioned "gem" electric lamps. He asked the vice-president whether he realized that the bank was using more than three times as much current as necessary. The vice-president replied that he knew that the old type of lamps was not efficient, but that the bank generated its current and therefore could not save much money by using a more efficient lamp! The evident fact was that while he knew that the "gem" type of incandescent lamp was inefficient, he had not known how exceedingly inefficient it was. If a man so intelligent and well read was thus ignorant about lighting economics, what is to be expected of the average user of electricity?

But, it may be asked, how has it happened that the public has not been better educated as to electric light economics? Have none of the manufacturers of electric lamps given adequate publicity to the efficiency of the newest lamps? Curiously enough the modern "tungsten filament" lamp, and its still more recent development, "the nitrogen or gas filled electric lamp," have not been sufficiently well advertised. When the "tungsten" (Mazda) lamp was invented some years ago, the manufacturers were not able to secure the co-operation of the electric companies, because the latter were naturally not eager to introduce a type of lamp that would give the same candle power as the old carbon "gem" lamp by the consumption of only 40 per cent as much electric current. Electric companies realized that public service commissions might not be easily induced to grant an increase in electric rates because of a reduced consumption of current, so the companies preferred to keep silent about the new tungsten lamp and let their customers use the old "gem" lamps. Gradually, however, the manufacturers of "tungsten" lamps began to induce the public to try the new lamp; but at no time was the new type of lamp "pushed" as vigorously as it would have been "pushed" had the manufacturers had the whole-hearted support of the companies.

This uneconomic situation arose because of the conflicting interests of the electric companies and the public, the conflict being accentuated by the existence of public service commissions that were addicted to cutting electric rates because they wanted public applause. There was not a single public service commission in all America farsighted and brave enough to force the public to adopt the new type of electric lamp and at the same time give the electric companies an increase in kilowatt hour rates.

For more than a decade a large percentage of users of electric lamps have failed to install "tungsten" lamps, mainly because they were ignorant of the merits of this type of lamp. It has remained for the U. S. Fuel Administration to accomplish what should have been done 10 years ago. The Fuel Administration has announced that on Aug. 28 the incandescent lamp manufacturers "voluntarily agreed to abandon the manufacture of certain types of the inefficient carbon filament lamp in accordance with the program which practically calls for the discontinuance of their manufacture and sale." The official statement adds:

"The importance of this radical step may be judged from the fact that the program as formally adopted at yesterday's meeting will mean the saving of more than 1,000,000 tons of coal."

If a million tons of coal, worth $4,000,000, will be saved annually by the elimination of carbon filament lamps, which now comprise about 15 per cent of the total, it is evident that fully a hundred million dollars' worth of coal have been wasted since the "tungsten" lamp was invented!

In the Aug. 21 issue of Engineering and Contracting it was shown that the introduction of the "skip stop" plan of operating street cars will save 1,500,000 tons of coal annually, or $6,000,000. This plan has long been known to engineers, having been in successful operation in Kansas City for seven years. Yet here again it remained for a Federal board, acting under a war emergency, to force the general adoption of a plan that is highly economic.

Last spring the U. S. Chamber of Commerce presented to Congress statistics showing that fully 800,000 tons of coal could be saved in electric and gas lighting by setting all clocks forward an hour, between April 1 and Oct. 31. If this "daylight saving" plan were extended throughout the year, more than a million tons of coal could be saved annually.

We have cited these three plans of fuel saving because they have all been put into partial if not complete effect. Important as these three means of saving coal are, they are small indeed compared with other available means. Of the 120,000,000 tons of coal annually used for domestic heating, fully 20 per cent can be readily saved by slight improvements in apparatus and methods. Of the 250,000,000 tons used for steam power, mechanical engineers estimate that 10 per cent can be saved simply by scientific firing. The railways use another 120,000,000 tons in a most extravagant manner, for both the locomotives and the methods of firing are far below what has been demontrated again and again to be an easily attainable standard of efficiency. Other industrials and steam ships consume 110,000,000 tons annually. Of the 600,000,000 annual total, it is a conservative engineering estimate that 10 per cent can be saved by the application of economic methods and with scarcely any change in apparatus or machinery. Hence Americans are now paying an ignorance tax amounting to a quarter of a billion dollars annually, merely because engineers who know how to effect this saving in coal have no authority to make their knowledge effective.

This huge sum is itself small beside other wastes preventable through the application of engineering knowledge. Typical of the wasteful influence of general ignorance, take the waste of water by cities because of failure to meter all consumers. Any experienced hydraulic engineer will tell the public that there are few cities that are not wasting fully one-third of the water. Not only does this mean a waste of one-third the coal used in pumping the water, but a waste in capital invested in pumps, reservoirs, filters and pipes. Yet the average city remains [illegible] order the universal installation of water meters wherever [illegible]

[illegible] the temporary economies that the Fuel Administration is effecting, and in greatly extending the field of compulsory introduction of economic methods and devices. It will not suffice hereafter for engineers merely to know what should be done and to wait until their advice is sought. They must be militant in spreading their knowledge and in forcing the adoption of plans that are demonstrably economic.

## A Handbook of Mechanical and Electrical Cost Data, Containing Much Matter of Value to Civil Engineers and Contractors

Thirteen years ago the "Handbook of Cost Data for Civil Engineers and Contractors," by Halbert P. Gillette, was published. A companion volume, entitled "Handbook of Mechanical and Electrical Cost Data," by Halbert P. Gillette and Richard T. Dana, has just been published by the McGraw-Hill Book Co., Inc., 239 West 39th St., New York City. The book contains 1,750 pages, handbook size and flexible binding, and the price is $6.

This new handbook fills a gap in cost data literature, covering as it does the entire field of mechanical and electrical engineering. Civil engineers and contractors who have anything to do with power, whether on a large or small scale, with lighting, heating, pumping, conveying, hoisting, etc., etc., will find a great deal in this book to aid them not merely in estimating first costs, installation costs, operating expenses, repairs, depreciation, etc., but in the selection of the most economic plant unit or in designing the most economic plant.

The data in the book are so presented, for the most part, that substitutions of local wages for those given enable anyone to apply the data to his own conditions. Shipping weights, sizes, capacities and net prices (f.o.b. factory) of nearly all standard machines (boilers, engines, pumps, motors, generators, transformers, etc.), are given in great detail. The general scope of the field covered in the 1,750 pages is indicated by the following list of chapters:

1. General Economic Principles.
2. Depreciation, Repairs and Renewals.
3. Buildings.
4. Chimneys.
5. Moving and Installing.
6. Fuel and Coal Handling.
7. Steam Power.
8. Internal Combustion Engines and Gas Producers.
9. Hydro-Electric Plants.
10. First Cost and Operating Expenses of Complete Electric Light and Power Plants.
11. Overhead Electrical Transmission and Distribution.
12. Underground Electrical Transmission and Distribution.
13. Lighting and Wiring.
14. Belts, Shafts and Motor Drives.
15. Compressed Air.
16. Gas Plants.
17. Pumps and Pumping.
18. Conveyors, Hoists, Cranes and Elevators.
19. [illegible] and Ice Making.
20. [illegible]
21. Miscellaneous.

[illegible] nomic principles.

[illegible] but, as stated in their preface, they have also used original [illegible] steam railways and public utilities total $650,000,000, and this appraisal work has enabled them to secure and arrange systematically a great mass of cost data.

Dana's "Handbook of Construction Plant and Its Cost" (700 pages), Gillette's "Handbook of Cost Data for Civil Engineers and Contractors" (1,850 pages), and Gillette and Dana's "Handbook of Mechanical and Electrical Cost Data" (1,750 pages) have been so written as not to overlap. Their combined 4,300 pages constitute a very comprehensive collection of economic data for engineers. Not the least useful to men in the civil engineering field is [illegible]

## A Great Blunder Made in Estimating the Cost of Carrying Magazines and Newspapers by Mail

The shortsighted, selfishness of most of the daily papers caused them to refrain from editorial comment on the zone postal law, except in few instances. They reasoned that the law would reduce the circulation of the general magazines and that consequently the daily papers would profit. But those very newspapers are likely to learn that there is no exception to the rule that every uneconomic public policy eventually reaches all pocketbooks and takes its toll.

General and "trade" magazines have been the greatest of educators. They have taught people to read advertisements as well as articles for the purpose of information. It can not be denied that prior to the advent of low-priced magazines, newspaper subscribers and advertisers were far less numerous per 1,000 of population than they are today. Magazines have not only increased the number of readers for themselves, but have, incidentally, increased the number for the newspapers; because once a man has become habituated to read, he tends to seek information from every kind of printed source. All this, however, has evidently been lost upon the daily press.

There are a few noteworthy exceptions. The morning edition of the Kansas City Star says:

> [illegible]
>
> [illegible]
>
> [illegible] of that town.

[illegible] cals and newspapers when they understand what is involved. It [illegible]

Had a great many other influential newspapers voiced an opinion like that just quoted, Congress never would have passed the unreasonable postal zone bill. So long as it was felt that most of the daily papers secretly favored the bill for selfish reasons, most congressmen felt safe in enacting the bill into law. In justice to the congressmen it should be said that they were deceived by the statements of the postoffice department and the "Hughes Commission" to the effect that carrying second-class mail costs the government 6 to 8 times the old 1 ct. per lb. rate. This was, of course, not an intentional deception, but arose from the fact that accountants instead of engineers were employed to analyze the costs of mail transportation and delivery.

In the near future we shall outline how an astounding blunder in cost analysis came to be made by the postal accountants—a blunder of the sort that would have disgraced the veriest tyro engineer had he made it. It adds one more instance to thousands that prove the inability of unscientific men to analyze complex costs properly. When accountants and lawyers attempt to make such analyses unguided by engineers or other scientific analysts, the result usually involves some sort of error, but never in the history of rate making has so far reaching a blunder been made as was involved in the reasoning by which it was concluded that it has been costing the postal department several times the price received for carrying second-class mail.

## "Why Engineers Should Prepare Revision of Public Utility Laws"

To the Editor: Referring to the editorial on page 272 of your Sept. 18th issue, under the heading "Why Engineers Should Prepare Revision of Public Utility Laws," the writer believes that the trouble with our organization is that we do not provide ourselves with the "gift of gab"; in other words, we spend too much time thinking and planning on problems to improve the operation and reduce both construction and operating costs, and do not give enough thought to, you might say, "public welfare conditions," or again, to the financial aspect in its relation to that of construction, the cost of financing and the necessary return on the investment to induce the financial interests to invest their money in public utilities, particularly to the extent and in the broad gage way it should be done for the public at large.

Recently in this state there was considerable agitation along the lines of placing an engineer on the Public Service Commission, which should be done. The statement was made by one of the lawyers in the case that the engineering profession is too narrow minded. Without going into the particulars of this case, it is perhaps fair, or more than fair, to say that the majority of lawyers in public utility cases have to be and are educated by the engineers. The engineer furnishes the data and the idea and leaves it to the lawyer to put it in such form that it can be placed before the Court or Public Service Commission, and the lawyer a great many times so obscures the facts set forth by flowery speech, or otherwise, that the real purpose of the matter in the case is overlooked.

Again, the attitude of the engineers in many instances is too narrow. They will not only hold down their own subordinates in the matter of payment of salary or compensation for services rendered, but this in turn gives the appearance at times that the engineers themselves do not consider their profession as worthy of the return that it should receive. Personally, the writer believes that such an attitude is all wrong and that it would be a good idea if the engineering societies could get together in some way and apportion a paper, or papers, to a certain number of engineers each month to be read and discussed before the local body, the idea being that it would force men who are naturally bashful about speaking in public or before a crowd to come to the front. This discussion should also cover public utility laws.

It might further be stated that if in times past the proper stand had been taken in reference to the earnings of public utilities, and in such a way as to allow a fixed per cent income, with an additional percentage return for each per cent the price of the commodity was reduced to the consumer, this reduction being given the consumer in the following year on which the earnings were based in the form of an increased or decreased discount on the commodity purchased, we would today be in a better position to finance our requirements during the war than we are at present; and it would relieve the Public Service Commissions and the utility companies of not only the burden and expense of all the hearings, but would provide the financial interests with assured information relative to what the earnings would be under prevailing conditions.

To this end, it is the writer's belief that all the engineering societies should get together and act in unity, even revising the aims as set forth in the respective constitutions if they are not at this time broad enough to permit broad action on the questions that have been brought before us, and will be further broadened in the future after the war is over.

A. E. Walden,
Superintendent and Chief Engineer Baltimore County Water & Electric Co.
Baltimore, Md.

## Standardization of Catalogs

To the Editor: In your issue of Sept. 11th appeared a suggestion from Wm. A. Wilcox regarding the filing of clippings, printed matter, etc. In this connection, those who are interested in this subject will no doubt be glad to know of the progress being made toward standardization of catalogs and printed matter.

The National Association of Purchasing Agents has felt the same need experienced by its members, and last May their standardization committee called a conference at Chicago, which was attended by representatives of twenty-three associations of trades and industries. Following that conference the committee decided that the facts presented showed very clearly that the only one size catalog which could meet the demand of all interested was 7½x10⅝ in. or its half size, 5¼x7½ in. The committee then recommended to the Association and they adopted unanimously those sizes for standard catalogs and printed matter which is to be filed with them.

This same size has been adopted as a standard also by the National Retail Hardware Association and the National Association of Brass Manufacturers, and it is under consideration by a number of other organizations.

The adoption of the standard size makes it possible to begin now the development of the plan of indexing catalogs and printed matter files. This involves the development of a standard indexing plan modified from the Dewey System to avoid the bulking of the numbers, as complained of by Mr. Wilcox. This plan remains to be developed, but indications are that there will be another conference on this subject some time in the near future.

W. L. Chandler,
Mishawaka, Ind. Dodge Sales & Engineering Co.

**Water Consumption in Metropolitan Water District, Boston.**—The average daily consumption of water in the Metropolitan Water District of Massachusetts during 1917 was 10,022,000 gal., or 90 gal. per capita per day. The entire district is 72 per cent metered. The consumption by the various towns and cities in the district was as follows:

| Ctiy or Town. | Gallons | | Per cent services metered. |
|---|---|---|---|
| | Total per day. | Per capita per day. | |
| Milton | 375,000 | 41 | 100 |
| Malden | 2,419,300 | 47 | 96 |
| Medford | 1,611,300 | 49 | 100 |
| Melrose | 992,900 | 51 | 100 |
| Winthrop | 727,200 | 52 | 100 |
| Belmont | 471,800 | 53 | 100 |
| Revere | 1,615,400 | 58 | 76 |
| Arlington | 997,100 | 61 | 100 |
| Quincy | 2,706,800 | 63 | 91 |
| Chelsea | 3,188,500 | 69 | 99 |
| Somerville | 6,676,100 | 73 | 74 |
| Lexington | 426,700 | 71 | 99 |
| Everett | 3,023,400 | 76 | 58 |
| Watertown | 1,584,600 | 89 | 100 |
| Nahant | 155,300 | 105 | 75 |
| Boston | 82,073,200 | 106 | 59 |

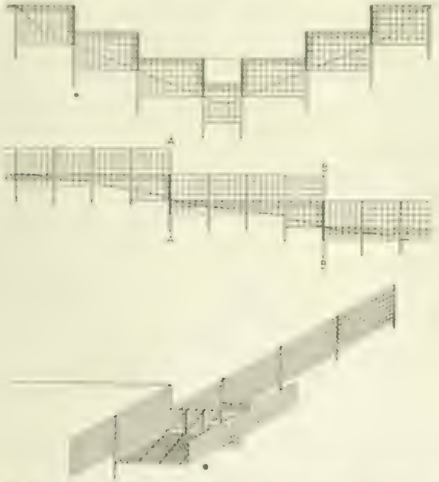
# A Novel and Economic Method of Controlling Streams

By HALBERT P. GILLETTE, [illegible]

Engineers who have had experience with creeks and rivers whose banks are easily eroded need not be told that the problem of stream control is not as simple as it seems. [illegible]

[illegible] made by engineers is to direct their entire attention to protecting the banks. [illegible] pensive bank construction is used and not always then.

Mr. Pratt's plan involves: (1) Control of the bottom longitudinally by means of a series of shallow "check" step-dams; (2) control of the sides, also, by a series of step-dams; (3) the use of posts or piles and wire netting for building these dams, and (4) the automatic filling in back of the dams with sand and gravel carried by the stream.



Upper View, Cross Section of Pratt Check Dam. Middle View, Longitudinal Section. Lower View, Details of [illegible] Showing Basket Bottom.

That the plan works well on a small scale the writer can vouch. Fig. 5 is a view, taken during low water, of one of these systems of check dams in Laurel Canyon, near Los Angeles. The protected channel is 25 ft. wide and about 9 ft. deep. The original grade of the stream varied from 3 to 10 per cent, but the creek now has a level bottom between the check dams, each of which steps up about 3 ft.

Before describing the Pratt system in detail attention may be called to the fact that it could often be used to protect bridges in streams that are given to sudden changes [illegible] original channel.

[illegible] dams. Posts are driven into the ground, or set in post holes, and pig-wire is fastened to them. The leaves and [illegible] and close the meshes sufficiently to retard the current until [illegible]

[illegible] one at A and one at B, whose cross-section [illegible] of pig-wire laid so as to form an apron [illegible] This prevents the erosion of the bottom by the water spilling over the crest of the dam.

[illegible]

[illegible] sand for the stream and its detritus. In a way that is really astonishing, the open wire dam retards the water, causes the sand to deposit and builds up the steps both longitudinally and laterally.

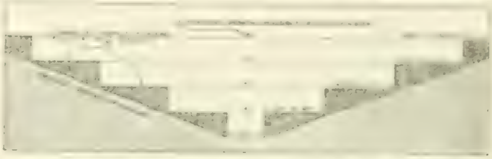


Fig. 4—Cross Section Showing How Slopes Are Built up by Deposits of Silt.

The object of the lateral stepping is to build up the banks in a manner that will secure their permanency. If there comes a break in any of these side banks it automatically repairs itself.

In the writer's travels he has seen a great number of expensive attempts to control streams without controlling the grades of their bottoms. Most of those attempts were either total or partial failures. The usual reason for failure is this: The capacity of a current for carrying debris varies as the cube of its velocity. Therefore even a slight decrease in velocity causes a deposition of detritus. The deposit deflects the current; and the deflected current, through centrifugal action, piles up on the outside of the curve. The surface of the water being higher at the outside of the curve than at the inside, there results a transverse current whose eroding action still further changes the bottom. And troubles never cease; for if the bottom is permitted to change, the entire course of the stream will [illegible] by very expensive structures. Even expensive bank protection—slope walls, piling, mattresses, etc.—are often undermined. If not undermined, the current may find its [illegible]

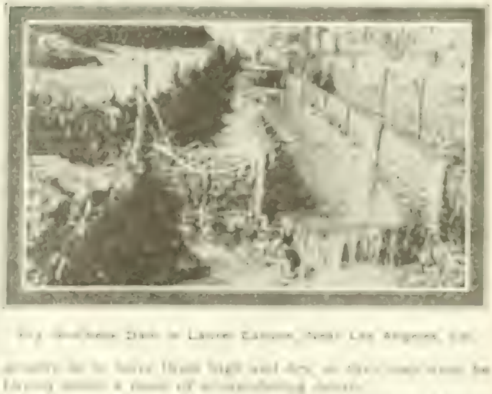


Fig. 5—Check Dam in Laurel Canyon, Near Los Angeles, Cal.

[illegible]

merit of Mr. Pratt's idea is the accomplishing of this plan in a very economic way. It seems to the writer that the plan is susceptible of economic application under a great variety of conditions.

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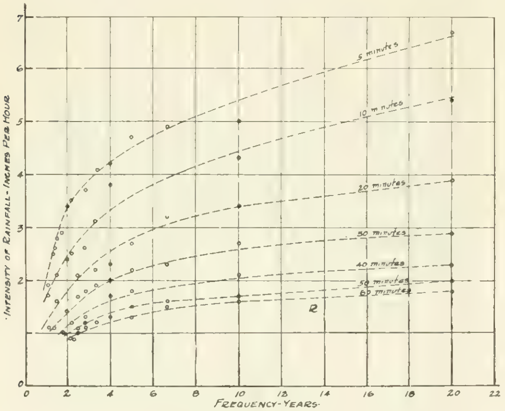
## Relation Between Frequency and Intensity of Rainfall

A series of rainfall curves for various sections of the country has been prepared by the U. S. Housing Bureau for the use of the engineers engaged in designing storm water sewage for the housing projects of the Bureau. Diagrams have been compiled for 23 cities, this number being considered as sufficient to represent the various parts of the country in which the housing projects of the government are located. The diagram for Boston, Mass., is reproduced below.

The diagrams have been made from data of excessive rainfalls contained in the annual reports of the U. S. Weather Bureau, in most cases beginning about 1896. The tables relating to excessive rainfalls contain records from self-registering rain gages of all storms in which the rate of fall equaled or exceeded 0.75 in. per hour.

The data have been plotted with ordinates representing intensities and abscissas representing average period in years between successive storms of the intensity and duration in question. Thus on the diagram for Boston, the point having an ordinate of two and abscissa of four, indicates that an intensity of 2 in. per hour for 30 minutes has been experienced on the average once in four years, during the period covered by the records; that is, there have occurred five storms during the entire period of 20 years in which the intensity for 30 minutes has equaled or exceeded 2 in. per hour. During this same period two of these storms equaled or exceeded 2.7 in. per hour as shown by the point (2.7) (10), and one storm had an intensity of about 2.9 in. per hour.



Relation Between Frequency and Intensity of Rainfall of Storms of Various Duration at Boston, Mass.

The diagrams not only give the intensities of rainfall for various periods of time, but the probable frequency of any given intensity and so give valuable information of the frequency and extent to which sewers designed for a given capacity are likely to be overtaxed. Thus if the capacity of a given sewer at Boston, for example, is dependent upon a 20-minute storm, then the diagram shows that an intensity of about 2.5 in. per hour can be expected about once in four years, and if the sewer be designed on this basis it may be expected that it will be overtaxed once in ten years to an extent produced by a rainfall intensity of 3.4 in. per hour.

The diagrams were prepared by Mr. E. P. Burke under the direction of Mr. F. E. Turneaure, both of the Housing Bureau, of which Mr. John W. Alvord is Chief Engineer.

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## Methods of Water Waste Elimination in a 100 Per Cent Metered City*

By H. P. T. MATTE,
Superintendent Water Department, Oak Park, Ill.

During the four-year period between 1913 and 1917 inclusive, although the population of Oak Park has increased 34.6 per cent and the number of services or meters 32.5 per cent, the daily consumption increased only 20.7 per cent. The daily per capita consumption has decreased from 75 gal. to 67.6 gal., or 10.6 per cent, the minimum night rate of consumption diminished 37.5 per cent and the ratio of the minimum night rate to the average daily consumption, dropped from 40.8 to 21.2 or 48 per cent. The percentage of water accounted for by meters has increased from 72 per cent to 83 per cent.

Oak Park has always been 100 per cent metered. All the water pumped into the distribution system, except that which is lost through underground leakage, is delivered through meters. This includes all municipal buildings, watering troughs, drinking fountains, street sprinkling water used in parks, and fire hydrants when used for other than fire purposes. Water used in the construction of houses is sold through meters buried in the parkway. Moreover, there is no free water.

**Maintenance of Meters.**—All meters are tested periodically, a practice which has been found profitable, although not required by the Public Utilities Commission. Meters are read every quarter in a continuous reading system, for which purpose the city is divided into six districts so that those found to be not registering can be brought into the shop, repaired and put back into service within a week after being read.

**Rigid Collection of High Bills Due to Leakage.**—This point is important and has a beneficial effect on the success of the meter system. In other words, although it may be hard on the consumer, he will, if properly impressed, appreciate the importance of watching his fixtures and become educated in spite of himself.

No reduction in bills is made on account of leakage. Short and pointed instructions, which include the policy of the Water Department, are printed on the backs of the water bills. If the complainant has been guilty of the characteristic failing of mankind, that of being unobserving and neglecting to read the information supplied to him every three months, he deserves to pay for his inattention.

This does not mean that the department is heartless and does not admit mistakes. The consumer is given the benefit of the doubt from the first, owing to the fact that the department realizes that it is but human and can be in error in several ways. In fact the department lets it be known that it is glad to correct its faults. If, however, upon thorough investigation it is found that the water was consumed through leakage or otherwise wasted, the bill must be paid. In order to be fair certain allowances are made if the waste was in the ground and invisible. In this case the lowest rate at which water is sold in Oak Park is allowed, although the quantity consumed may not justify the consumption to be placed in that class.

In any case of high bills, whether this concession is given or not, if the consumer is plainly unable to pay the bill as it stands (these claims being investigated), an installment plan of payment is adopted; but with the provision that the bill must be paid within a year.

The reason for this attitude is this: Every student of human nature knows that if a water department is reputed to be lenient, the average person takes a chance and depends upon his ability as a bluffer to get out of paying the bill. Talk is cheaper than plumbing bills. If he is victorious because "he has been unfortunate and won't let it happen again," he surely will. In the old days of leniency it was found that the average consumer did do it again.

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*Abstract of paper presented before the Illinois Section of the American Waterworks Association.

**Complaint Department.**—[illegible] the meter reader is in collusion with the "bunch of graft- [illegible] and so on.

Oak Park, however, is prepared to prove to all these [illegible] is a record of all complaints of whatever nature that have been made to the water department and about the water [illegible] years in 3 by 5-in. card files, and are the original records. All calls are recorded on the same size cards, three colors being used to distinguish between complaints relating to meters and bills, complaints and job orders relating to the mechanical division, and those relating to delinquent bills. This record is very valuable in refuting unjust accusations, in tracing past records, and for the purpose of settling especially difficult problems.

All complaints concerning high bills are investigated and a comprehensive written report is made to the consumer. The nature of the complaint is written on the card provided for that purpose and is given to an inspector who makes a specialty of investigating high bills. It has been found impracticable for the meter reader to waste time making investigations. He notes all unusual sounds or evident leakage on the reading slip and a special call is made. Sometimes a consumer is dissatisfied even after a second investigation, and he is allowed to hold the payment of the bill until the next quarterly statement, when he will see for himself the result of stopping small leaks. If, however, a rebate is yet expected or sought, a final notice of "Shut off for non-payment" is issued and the water is shut off in spite of threats of litigation.

For the purpose of determining the cause of persistent high bills, where "there are only two in the family, no leaks, and there is no sprinkling done; while the family next door has three or four children, does its own washing, sprinkles the lawn all day, and has only minimum bills," the department has evolved a recording detector which is substituted for the meter and which gives a graphic record of the consumption for 24 hours or a week. It is thus possible to spot the number of times the faucets are opened, the number of baths with the quantity used each time, and the number of times the toilets are used. It has thus been possible on many occasions to show that the toilet would not work about every fifth time it was operated, and that the lady of the house was apparently too clean, having the habit of letting the water run in the kitchen sink too long each day or that somebody took a cold bath every morning and consumed about 50 gal. each day in the operation, or that a thermostat used by a central heating plant leaked at some time during the day, or that the toilet was used too often to wash down foreign substances that did not belong there, or finally that the servant was very wasteful.

The complaints on account of high bills dropped in num- [illegible] of the consumers who, realizing that the department means business, is strictly impartial and is able to help them reduce their water bills, have begun to co-operate with the department.

**Recording Pressure Gages and Master Meter.**—The third [illegible] devices is a great aid in estimating the rate of consump- [illegible] waste survey. The efficiency of the pumping station attendants as well as that of the pumps can be determined at a glance. Many plants are equipped with Venturi meters or pitometer recorders placed on the main leading [illegible]

**Periodical Waste Surveys.**—The waste survey is one of the most important elements in the prevention of con- [illegible]

In order to shorten the work of making waste surveys and avoid unnecessary work, it is advisable to make first a rough survey of the entire city with a pitometer, which [illegible] the water consumed through one of the mains as a feeder. Here is where the master meter on the distribution sys- [illegible] shuts down large districts for a few minutes and notes the drop on the Venturi chart. It is impossible to do this at night because the quantity is only 400 gal. per minute between the hours of 1 and 4 a. m. In fact the smallest pump is so throttled in order to maintain the assumed pressure of 40 lb. that the opening left is equal in area to that of a 2-in. pipe. The Venturi meter is not sensitive enough at that low velocity; but it is possible to accomplish nearly the same result in the day time during periods of steady consumption when there is a draft of 2,000 or 3,000 gal. per minute. In this case the drop has been found sufficient to allow the making of an analysis of the leakage conditions. The pitometer is the surest way, however, for it is possible with it to obtain accurate information and so eliminate the "good districts."

After the pitometer survey, especially when the leakage is so small that there is little velocity in the mains, the "hydrant and hose method" follows logically. It is practically useless to expect any headway if a displacement meter is used, as the rate of consumption and the minimum flow cannot be accurately determined. The Oak Park department uses a 2-in. Venturi meter, but a pitometer inserted into a short piece of pipe 2 in. or smaller in size is as good. A manometer and as much condemned fire hose as can be obtained from the fire department, completes the outfit.

During the summer of 1917 the department tested 18 miles of mains, and stopped leakage amounting to 220,000 gal. per day. This represents a saving in the cost of water purchased from the city of Chicago, of $5,000 and the outfit used cost only $150, exclusive of the hose. It also accomplished the reduction of the night rate of consumption to the assumed standard of 20 per cent of the average daily consumption.

It has been the Oak Park experience that in order to be most efficient, a water department must be under one head. That is, not only should the manager take care of the mechanical end of the water works system but also the financial part. He should also inaugurate the policies. It is very difficult to handle complaints regarding high bills and to give satisfaction if the money is collected in one department, "shut-offs" for non-payment of bills are handled in another, and the bills are rendered in either of the foregoing or yet in a third one.

## State Drainage Laws

[illegible] ment Bankers' Association of America has prepared, and is now having published, a book containing a synopsis of [illegible] contain approximately 400 pages. It will be bound in buckram, and is being offered by the committee to the members of its association, and to any contractors or en- [illegible] covers the expense the committee has been put to in getting out this publication. John R. Longmire, Mississippi [illegible] member of the committee.

# Station Work Solves Labor Problem in Constructing Concrete Aqueduct of Winnipeg Water Supply

By F. P. KEMON.

The new water supply of Winnipeg, Manitoba, will be brought to the city by an aqueduct, 97 miles in length, extending to Shoal Lake, a subsidiary of the Lake of the Woods. The aqueduct passes through a flat, barren uninhabited bush country consisting of muskey and tamrack swamps, and has a fall of 300 ft. in the 97 miles. A standard gage railroad for construction purposes was built approximately 150 ft. distant and parallel to center line of aqueduct. Over this railroad a passenger train is run three days a week to bring men, provisions and mail to the camps along the line.

Bucyrus drag lines were used for the trench excavation. The trenches were approximately 22 ft. wide and from 4 to 32 ft. deep. The excavation was made as near as possible to within 6 in. of required depth. This final cut was removed by hand excavation so that the bottom of trench could be shaped to the required type of invert used to suit the nature of ground encountered. There were three different types of inverts used throughout the work. Excavated material was placed by drag lines along side of the trench so as to form an embankment upon which to build a 3 ft. gage railroad to be used in placing concrete. A template was employed to keep the center of embankment parallel to, and the proper distance from, the center line of aqueduct, so that the traveling concrete chutes would work properly in pouring concrete.

**Reasons for Adopting Station Work System.**—Owing to the scarcity of labor due to the war, and the limited period in which work of this nature could be prosecuted on account of long, severe winters, the contractors at the beginning of the 1917 season were confronted with a serious problem to get the requisite amount of construction finished. Station work was decided upon, it being the intention to sub-contract the work so as to offer inducements to the men to work a little harder and thereby get along with a smaller labor force than would be required working on the hourly basis. The idea was to offer prices that would allow the men to earn 10 ct. to 15 ct. per hour more by the extra effort put forth. The rate of wages on the hourly basis at this time was 30 ct. to 40 ct. per hour.

**Classes of Labor and Their Efficiency.**—The laborers represented a number of different nationalities, including Belgians, Russians, Austrians, Swedes, Poles and Norwegians. On account of the scarcity of labor it became impossible to maintain any discipline among the men, they taking undue advantage and conducting themselves pretty much as they pleased. When the station work was at first proposed to them they did not want to accept it; they seemed very suspicious and were afraid of being taken advantage of, and in some instances, large numbers of them left the work, as many as 50 to 75 leaving different camps along the line at one time. These were mostly Austrians and they proved to be the hardest to handle and the last to take hold of the station work. The Belgians were the first to accept it and also proved to be the best station men with Swedes second and Norwegians third. After these men had worked a short time at the station work and found they could make more money than on the hourly basis there was no further trouble experienced in letting the work, and the plan proved very successful as far as conserving man power was concerned, the work being prosecuted in some instances with a third less men. The work, owing to its continued sameness, also turned out to be ideal for the system.

**Prices and Working Hours for Station Men.**—A schedule of prices to be paid was made up by the chief engineer but this could not be strictly adhered to on account of the constant changing of local conditions as work progressed at the ten different camps along the line. Accordingly, the letting of the work and the prices to be paid had to be left to the judgment of the men in charge at the camps.

After the men began on the station work basis no regular schedule of working hours was adhered to as in most instances men would get out an hour or two before breakfast and would always work several hours in the evening after supper. The men in a short time also developed a keen insight into the cost of doing the work and would offer all kinds of arguments to increase the price. They were absolutely void of any integrity as to continuing a contract. If, after a few days' trial the job did not prove to be as profitable as they had anticipated, they had no hesitation in throwing it up and going to other camps looking for new work. These tactics being numerous resulted in a hardship on the men in charge, and they had to exercise considerable care and diplomacy in order to keep the cost of the work down and still continue the station work.

**Earnings of Station Men.**—When a contract was let and work begun the resident engineer for the contractor would record the station and also when a contract was finished. The men were paid on a basis of his report. They earned from $8 to $12 per day on the station work. They usually worked in gangs with one of the party acting as leader or foreman. This man would do the bidding for the gang and they would be governed by him. It often occurred that one gang would take three or four different contracts in order to work continuously throughout the day and when it was not possible to do this the men would work for one or two hours during the day while waiting for additional station work to become ready.

**Cost of Embankment Grading and Box Drains.**—The grading of the embankment alongside the trench for the concreting plants was the first contract let on the station work basis. The price for this was from 3 ct. to 6 ct. per lineal foot, according to amount and nature of the material to be handled. One or two men usually performed this work.

A wood box drain 8 in. x 10 in. in cross section was next placed in the center of the trench. It was set 2 in. below bottom of invert grade with a 2 in. layer of screened gravel placed on all four sides of the drain. The box drains were built of 2 in. x 6 in. x 16 ft. sides with 1 in. tops and bottoms and were nailed together by contract for 1½ ct. per lineal foot. Excavating for and setting box drains, including placing gravel, was let for from 5 ct. to 10 ct. per lineal foot, according to nature of material excavated, which varied from quicksand and muskeg to solid rock. Four to eight men usually worked at this contract. Cross drains were also placed at intervals of about 500 ft. They drained water to sumps outside of the line of aqueduct. The water was pumped out of the trench with gasoline diaphgram pumps. The gravel used around box drains was placed in the trench alongside of excavation and was not included in contract.

**Setting Up and Dismantling Invert Forms.**—Following the placing of box drain, pioneer invert forms 13 ft. x 15 ft. x 6 in. to 24 in., with a copper strip 4 in. wide at each end of form for water proofing joint, were set up at from $1.75 to $2.50 each, according to size. They were dismantled and carried ahead to point of re-erection for 75 ct. per form. Four men erected forms and three men dismantled them and moved them ahead. After the concrete was poured in the invert forms it was screeded by three men at 75 ct. per invert and trowel finished by two finishers at from 75 ct. to 90 ct. per invert, including the placing of a cedar strip in the center of the haunch to prevent seepage at the joint between the invert and arch.

**Handling Steel Forms for Arch.**—Blaw steel forms in 45 ft. sections were used for arches. Six inside and four outside forms and steel inside and outside traveler for moving them were assigned to each camp. These forms and travelers were first erected in the trench on the hour wage basis. Later contracts were let at from $20 to $27.50 per arch, including the laying of traveler tracks, dismantling, moving ahead and erecting complete ready to receive concrete. This work required from 8 to 12 men, and they set up three to four arch forms per day. A dinkey was furnished to pull the [illegible] when the forms were loaded.

**Concrete Mixing Plant and Handling of Aggregate.**—[illegible] railroad in such [illegible]

[illegible]

**Hauling and Placing Concrete.**—[illegible] plant. [illegible] yd. [illegible]

[illegible]

[illegible] ten men were always required to do this work on the hourly basis. [illegible] track and were moved ahead by men who dumped the cars [illegible]

**Foundation Fill and Backfill.**—Coal for drag lines and [illegible] tions and placed under water in trench. This material was delivered in air dump cars, dumped along the right of way opposite to where it was to be used, loaded into wheelbarrows by hand and dumped from runways over trench for 30 to 40 ct. per cubic yard. In some sections the ground was so soft it would not carry the embankment placed alongside of the trench. In such instances two drag lines had to be used to relay material excavated from trench a safe distance from the edge of the trench to prevent caving of banks. Trestles had to be built to place concrete. These trestles were let at from 25 ct. to 45 ct. per lineal foot, including cutting of timber required from bushes along right of way.

A portion of the backfill was required to be placed by hand in 12-in. layers an dtamped. This work was let for 7½ ct. per foot per side of trench. After this work was finished drag lines completed the backfilling when top and slopes of backfill were dressed to template at 4 ct. per lineal foot of trench. After this seeding was done on the hour wage basis.

Each camp consisted of from 12 to 15 frame buildings, made in battoned sections so they could be conveniently taken down and moved to the next camp site. This was let at from $500 to $700 per camp. Accommodations were provided for from 100 to 150 men at each camp, and they were boarded at $5 per week. The work was executed by the Winnipeg Aqueduct Construction Co., Mr. Wm. Smail, General Superintendent, and Mr. W. G. Davies Chief Engineer, the writer being in direct charge of camps Nos. 1 and 5.

## Water Waste Warnings on Back of Water Bill

The Water Department of Oak Park, Ill., utilizes the back of its water bills for admonitions to the consumer regarding the waste of water. The following notice appears on the back of each bill:

**WHAT YOUR SMALL LEAKS COST YOU**

| SIZE STREAM | OPENING | GALS. PER DAY | COST PER QUARTER |
|---|---|---|---|
| $\frac{1}{8}$ | ● | 3000 | $48.60 |
| $\frac{1}{16}$ | ● | 700 | 11.70 |
| $\frac{1}{32}$ | • | 175 | 2.84 |
| $\frac{1}{64}$ | · | 44 | .71 |
| STEADY DROP. DROP | | 24 | .39 |

**WATCH YOUR FIXTURES**

Do not neglect leaking toilets—for a small leak will waste from $10.00 to $50.00 worth of water a year. This leak may occur without being visible, but it can be detected by listening on the pipe leading from the tank or on the tank itself.

Do not suspect the meter if your water bills are too high. It registers all of the water consumed whether used or merely wasted—but no more. When a water meter is worn or defective it either allows water to pass through without registering the flow at all, or else under-registers.

All water passing through a meter will be charged for whether used or wasted—and no reductions will be made on account of leaks.

Meters will be tested by the Water Department upon the request of the consumer—but if the test shall establish the accuracy of the meter within 2 per cent, the customer will be required to pay $2.00 for the expense of making the test.

The table, "What Your Small Leaks Cost You," is not based upon mere thory, but the various openings were tested in Oak Park at the averag epressure of 45 lb. per square inch.

**4,830 Acres of War Gardens in Chicago**—It is estimated that war gardens in the city of Chicago alone produced crops during the recent season to the value of $3,500,000. A total of 4,830 acres was under cultivation as the result of the labor of 250,000 individual war gardeners. In the suburbs at least 90 per cent of the vacant land was under cultivation and a crop was produced fully as great as that of the city proper.

## Methods of Eradicating Mosquitoes in Malarial Control Campaign*

By C. N. HARRUB,

Sanitary Engineer, U. S. Public Health Service.

The line of procedure to follow in endeavoring to reduce the malaria incidence is to break the line of transmission from patient to well person. As it is definitely known that malaria is transmitted only through the agency of the Anophelene mosquitoes, this is the logical point of attack. No mosquitoes, no malaria. Hence the elimination of malaria reduces itself to a question of eradication of the mosquito. This is best accomplished by making it impossible for them to breed. The first three stages of the life of a mosquito, viz.: the egg, the larva and the pupa, are spent in water, and without water it is impossible for them to propagate. The problem thus becomes one of getting rid of all water possible or rendering it unfit for mosquito breeding. This may be accomplished in one of four different ways, but in practice it may be found necessary to employ all of these methods on the same piece of work. The four methods are: 1. Drainage. 2. Oiling. 3. Fish control. 4. Larvacides.

Drainage as an anti-malaria measure may be subdivided into several heads. 1. Training natural streams and water courses. 2. Construction of open ditches. 3. Lining ditches. 4. Subsurface drains. 5. Filling. 6. Maintenance.

**Training Streams.**—As mosquitoes breed in running water as well as in stagnant pools, it is necessary as a control measure to put them into such condition that the development can be arrested before adult mosquito is produced. This consists in clearing the channels of all obstructions, straightening the course where possible, and regrading the beds so as to confine the water to as narrow an area as possible, and to give the stream an increased current. Difficulty is sometimes encountered in this work, especially in low flat ground. The stream banks should be clean-cut and all obstructions removed to minimize the chances for floatage to collect, and also to provide an edge which minnows may approach. On streams which dry out soon after storms, depressions in which water may pool and produce mosquitoes should be filled so that the water will drain off.

**Construction of Open Ditches.**—Open ditches should be as straight as possible, and should have clean-cut slipping edges, and narrow bottoms. They should also be as few as possible. In digging such a system of ditches the main ditch should be dug first, and then such laterals as are indicated. In joining a lateral to the main ditch it should be given a down-stream direction to prevent the deposition of silt and sand at the junction.

**Lining Ditches.**—In some cases where the maintenance of open ditches is too expensive it is found advantageous to line them, or portions of them, with concrete. It is not always necessary to line them for their full depth, but just the bottom and a small distance up the sides. Lined ditches are much more easily cleaned than open ones. Care must be taken in their construction to provide sufficient anchorage so that the lining will not be washed out.

**Subsurface Drainage.**—Tile pipe is used in subsurface drainage, and the object is to lower the water table, so that storm water will be more rapidly absorbed by the ground. It is also used to intercept seepage from hillsides.

**Filling.**—Where the collection of water cannot be economically drained, filling must be resorted to. If the area to be filled is too large it may be partially filled so that the reduced water area may be controlled more easily. As a rule draining is more satisfactory and cheaper than filling.

**Maintenance.**—Under maintenance comes any measures necessary to keep the ditches in their most efficient condition, such as removal of collection of debris, regrading, etc. Vegetation will grow up in the ditches, and must be removed. In ditches which always contain water aquatic growths and algae often have to be combatted. In such cases copper sulphate will be found very useful. Ditches should be inspected at frequent intervals to see that they are free from obstructions and records should be kept of such inspections. These should show the work performed and the materials used, so that costs may be figured. It is well to have a map of the area with the locations of all ditches shown on it.

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*From a paper presented Aug. 1 before the City Health Officers of the State of Florida.

**Oiling.**—Oiling may be used as a supplementary control measure when funds for proper drainage are not available, or until drainage work can be done. The object of oiling is to kill the larvae before they can develop into mosquitoes, and also to render the water disagreeable to the mosquitoes so they will not deposit their eggs in it. The principal requisite for an oil in mosquito control work is that it shall spread well so as to form a thin film over the surface of the water. There are many kinds of oil which are effective in this work, ranging in density from kerosene to crude oil. Kerosene has been used quite extensively, and has some advantages over some of the other grades. It forms a thin film, spreads rapidly, and is easily obtained. Its chief objection is that it evaporates rather quickly. To overcome this feature it may be mixed with a heavier oil. The general practice today is to mix it with crude or some other heavy oil, the mixture being so proportioned that it works well in the sprayers and readily spreads to form the film on the surface of the water. The percentage of kerosene in the mixture varies considerably and may be as high as 75 to 80 per cent. The film is more permanent with such a mixture than with kerosene alone.

Oil may be applied successfully to pools, ditches, streams and edges of ponds and rivers. It should also be used in such containers as fire barrels and similar storage places. In ponds or streams of large size it is unnecessary and useless to endeavor to cover the entire area, because the larvae are seldom found in the deep water and because a film of large dimensions will be easily broken up by wind action and driven all to one side.

Wherever oil is used care should be taken to see that all debris, such as floatage, weeds, etc., are cleared out. The efficiency of the oil film depends entirely on its continuity and if grasses or weeds and sticks are left penetrating the water surface, they not only interfere with the spreading of the film, but the film will not come in contact with them at the water surface. A small annular space is left around each grass or stick and here the larvae may come to breathe. An excessive amount of oil will sometimes overcome this difficulty, but this method is too expensive for general practice.

**Methods of Applying Oil.**—Oil may be applied in any of a number of ways, for example: 1. By means of a common garden sprinkling pot. 2. Knapsack sprayer. 3. Drip cans. 4. Small bundle of oil soaked cotton waste. 5. Sprayer from a boat. 6. Thrown from a small dipper.

This last method is only a makeshift, is wasteful of oil, and should never be considered as a permanent method of distribution.

(1) The field of usefulness of the sprinkling pot is limited to small areas, where all parts of the propagation area are easily accessible.

(2) The knapsack sprayer is best for general use. It increases the range over which the oil may be spread, by the operator being able to cover a radius of 20 ft., if desired. The can holds 5 gal., and is carried on the back of the operator, thus leaving both hands free while not operating the sprayer. This is a great advantage when traveling over rough ground.

(3) Drip cans are used on small streams. The can is placed about 3 or 4 ft. above the water level so that the force of the fall will break up the drop of oil and immediately spread it out in the required film. The rate of dripping depends on the size of the stream and its velocity. In a small stream a foot or so in width 10 to 20 drops per minute will usually suffice. On larger streams as many as 60 drops per minute may be required. This is a matter which should be determined by trial. Whenever possible it is best to place the drip can so that the oil falls on a rather swift part of the stream such as a small rapids. This aids in breaking up the drop, which then spreads out over the quieter water below.

Various kinds of drip cans are used, different kinds of oil requiring different methods of handling.

(4) The oil-soaked cotton waste is a sort of modification of the drip can, and is used on streams where the flow is too small to require the use of a drip can. The waste is dipped in the oil and then squeezed just enough to stop the dripping. It is then fastened by wire in the bed of the stream at its headwaters. The oil gradually works out and forms the required film. It will serve for about a week and must then be re-dipped.

(5) Hand pumps and sprayers are used in small flat bottomed boats to spray the edges of streams, lagoons, etc., where drainage cannot be economically employed.

**Fish Control.**—In certain localities malaria control work is very materially assisted by fish. The top feeding minnow, Gambusia Affinis, is the deadly enemy of the mosquito larvae, and in localities where they abound are the means of destroying large numbers of the wigglers. If given a little assistance they will often entirely prevent the development of mosquitoes in a pool. In order to make them most efficient it is necessary to keep clean smooth edges on the pool or stream and to remove all floatage in which the wigglers may hide. Small pools may be stocked with these minnows and oiling thereby rendered unnecessary. Such pools should be inspected frequently in order to be sure that the fish control is effective.

Larvacides.—Under certain conditions larvacides may be used in malaria control work, but as a rule they are less satisfactory and more expensive than draining or oiling. Larvacides are poisonous and should therefore be used with care and discretion. They may kill fish and other aquatic life if applied too freely, and by thus destroying the top feeding minnows destroy one of the best natural agents in mosquito control that we have. Larvacides may be used to best advantage in such containers as fire barrels, where they can not injure stock, or kill forms of life other than those for which it is intended. One feature in favor of some larvacides is the fact that one application is sufficient for a whole season, or until the water is changed. Such a one is nitre cake.

**Prophylaxis and Screening.**—In addition to the above-mentioned methods of control, which are designed to eliminate the mosquito, prophylaxis and screening may in certain cases be used to advantage. In prophylactic work quinine is used. The dose varies with the object in view, a larger dose being used to produce immunity than to simply ward off the disease. It has been used very effectively in Italy among the rural population. For the 10 years preceding 1902 the average annual death rate was above 14,000. At that time quinine phophylaxis was started, with the result that in 10 years the rate had been reduced to a little over 3,000, or about 25 per cent of the former figure. As no other means of control were employed during this time quinine must be given the credit for this reduction. It has also been used with equally good results in Greece, Algeria, Brazil, Formosa and German East Africa.

Screening of houses should be done in all malarial localities, but cannot be considered by itself as an efficient method of control.

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**Iowa Section of Am. W. W. Assoc. Meeting.**—The fourth annual meeting of the Iowa Section of the American Waterworks Association will be held in Iowa City, Ia., Oct. 23 and 24. Prof. J. H. Dunlap, State University of Iowa, Iowa City, is acting secretary and treasurer of the section.

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**Women Gas Meter Readers.**—The Haverhill Gas Co., of Haverhill, Mass., is employing women to read its meters.

# Preliminary Analysis of Degree and Nature of Bacterial Removal in Filtration Plants*

By ABEL WOLMAN,
Division Engineer, Maryland State Department of Health.

The determination of a law of bacterial removal by rapid sand water filtration plants is of great practical importance and utility. Such determinations of plant efficiencies are valuable as indicators not only of present but also of future performance. It is quite evident that it would be desirable to measure quantitatively the performance of a plant in such a way as to obtain a comparative conception of how well or how badly it is being operated. Since at present no agreement exists among operators, designers, or public health officials as to standard of "good performance," because, in the past, agreement has been prevented by the interminable search for a "standard effluent," itself the subject of disagreement, it becomes necessary to attack the problem of rating or standardizing plant accomplishment from another angle. In this discussion, an initial search is made for certain basic characteristics of rapid sand filtration. The term, rapid sand filtration, is here used more broadly than usually, to describe the entire process from preliminary coagulation through sedimentation or settling, filtration, and disinfection.

The measure of variable phenomena by comparison with ideal or "normal" conditions is a procedure common to scientific analysis. The application of this method offers here a fruitful means of testing our ideas of filtration efficiency. The first problem obviously consists in the attempt to determine a possible correlation between the number of bacteria in the final effluent of a filtration plant and the number in the raw water. A numerical statement of the problem should be clearer. If a plant uses a raw water containing 500 bacteria per cubic centimeter and produces an effluent containing 10 per cubic centimeter, will the same plant produce an effluent of 20 per cubic centimeter when the raw water content is 1000 per cubic centimeter? Can one predict, in other words, with any degree of precision, what effluent counts should be normally attainable with varying raw water counts?

**Deduction of Standard from Normal Performance.**—The normal or ideal performance from which it is possible to obtain hypotheses as to standard empirical accomplishment is not difficult to deduce. The "normal empirical performance" may be defined as the accomplishment of a filtration plant which is known to be operating successfully. Successful operation can be said to exist wherever there is an unquestioned superior bacteriological and physical quality of effluent, consistent performance, excellent control, and scientific observation of operating details. Plants whose performance may be used as the basis for comparison and for the derivation of the law of bacterial removal are not at all rare. In this analysis, the operating statistics of the filtration plant at Avalon, Md., owned by the Baltimore County Water & Electric Co. and operated by S. T. Powell, were used.

This plant obtains its raw water from the Patapsco River, a highly polluted stream, ranging in turbidity during the year from 0 to 5000 parts per million and in bacterial content (20°C. gelatine-48 hours), from several hundred to 150,000 per cubic centimeter. The watershed of the stream is composed largely of cultivated areas, with no large sewage polluting influences. This water is treated with aluminum sulphate, at an average rate of 0.8 grain per gallon, and is then allowed to settle for four hours. After leaving the sedimentation basin it is treated with calcium hypochlorite with an average dose of 0.34 part per million, and then passes through the rapid sand filters which have a capacity of 2,500,000 gal. per day.

The plant is controlled scientifically by a trained operator with the aid of modern equipment and laboratory observation. During several years of operation the bacterial content of the effluent has not exceeded, at any time, 20 bacteria per cubic centimeter. Presumptive tests for B. coli in lactose broth have indicated positive tests in 1 cc. less than 2 per cent of the time during any year. The number and kinds of bacteria are determined in raw water and final effluent every day and general experimental data are constantly collected. It is clear, therefore, that the plant in Baltimore County approaches so closely, from the standpoint of operating results, the ideal plant as to justify the use of its performance as the basis of a law of filtration.

**Determining Characteristic Empirical Performance Curve.**—In order to determine with some degree of accuracy the form of a characteristic empirical performance curve, the results of raw water and final effluent counts of the Avalon plant were plotted. In order to avoid plotting a mass of points which would tend to confuse, 7-day averages of both stations, rather than daily results extending over a period of nineteen months in 1915, 1916 and 1917, were used. In plotting these values, approximately 520 daily analyses were summarized. These were obtained in consecutive months and under every phase of operating conditions. No counts were discarded as being unfair or incorrect.

A study of the samples plotted reveals at once a consistency of arrangement. It is clear, too, that the performance of this normal plant is represented by the curves. Inasmuch as these curves are practically straight lines, within the limits shown, the derivation of their equation is simple. The equation of a straight line, when the results have been plotted on a logarithmic basis, is given by: $c = \log y \div \log x$, where $c$ is a constant for this particular plant, and $y$ and $x$ are respectively the raw water and final effluent counts.

It would appear, therefore, that the "normal empirical performance" is represented by a curve having the equation: $y = x^c$. A tentative hypothesis, with regard to bacterial removal by filtration action, may be promulgated, therefore, as follow: The final effluent count, under normal operating conditions, is an exponential function of the raw water count. This hypothesis provides a means of determining whether or not a plant under scrutiny is, at least, "performing normally," where normal performance would be interpreted as conformity to the logarithmic curve of filtration.

The "normal performance" curve demonstrates the fallacy of assuming that the **difficulty** of removal of bacteria is relatively the same regardless of the number of bacteria in the raw water. Although this assumption is rarely publicly proclaimed, it is usually summoned, however, to the aid of those plants which, for one reason or another, are so successful as to require a specious hypothesis, fairly reasonable to the layman, to support their claims to maximum efficiency of 99 per cent plus. The practical results of a scientifically controlled plant certainly seem to lead to the conclusion that increases in raw water bacterial content decrease the corresponding bacterial content **interval** in the final effluent.

It should be added, too, that the equation of normal performance, $y = x^c$, offers a new quantitative measure of the efficiency of any plant, obtained by evaluating in any case the constant, $c$. Such a measure, among other qualities, has the advantage of a rational basis and of a practical significance.

**Value of Coefficient of Efficiency.**—What absolute value this constant, $c$, or the so-called "coefficient of efficiency," should attain is dependent upon individual opinion of "good performance." It is of interest to note, however, that, in a survey of 19 rapid sand filtration plants, varying in size from 2,200,000 gal. to 80,000,000 gal. filtered per day, the coefficient of efficiency of these plants has attained an annual average of over 2.5. The raw waters which these plants had to treat contained turbidities ranging from an annual average of 1 to 561 parts per million, and average bacterial contents from 350 to 16,500 per cubic centimeter. The 19 plants chosen, therefore, for the evaluation of $c$, are representative, in their initial conditions, of rapid sand filtration.

The probable existence of the law of filtration, $y = x^c$, combined with known values of $c$, practically attainable, gives the investigator of filtration plant accomplishment the fundamental criteria with which to measure both the character and the amount of removal in any particular plant. The objection may be raised to the above method of critical standardization of plants, that all do not function in a similar manner, on account of differences in raw water, resulting from peculiarities of suspended matter, variations in resistance of bacteria, and other similar factors. This objection does not seem to the author to be entirely valid, since peculiar characteristics of raw water are usually provided for by variations in design, such as increased periods of sedimentation and greater doses of disinfectant. It is reasonable to suppose, therefore, that given plants, initially properly designed for local conditions, should function according to some common law, since death rates under disinfection, devitalization and sedimentation and filtration of bacteria differ in the degree, but not in the kind, of changes effected.

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*Abstract of a paper presented at the St. Louis Convention of the American Waterworks Association.

The preliminary theory of bacterial removal by filtration is supported by the average monthly results from several large rapid sand plants in the United States. It is quite obvious that each plant follows in its performance the characteristic $y = x^c$ curve.

Since the death-rate of bacteria under the action of disinfectants, and under well defined conditions, has been shown, to follow in general the law: $c = \frac{1}{t - t_1} \log \frac{y}{x}$, it will be necessary to look for the causative factors of the $y = x^c$ law in other phases of the system of rapid sand filtration.

## Cost of Ash Collection at Philadelphia with Motor Trucks

Trucks equipped with special dumping bodies are employed by the city of Philadelphia for removing ashes. Ten Mack trucks are used for this work. Each truck has a capacity of 10 cu. yd. and makes from 5 to 7 trips per day, with a total mileage of about 60. On the assumption that each truck averages 6 full trips per day, the cost of collecting and disposal of ashes is 31.9 ct. per cubic yard. The daily cost per truck is $19.15, of which $7.75 is fixed charges, and $11.40 is the operating cost. The fixed charges per day are:

| | |
|---|---|
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| Total | [illegible] |

The operating cost per mile is as follows:

| | |
|---|---|
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| Total | [illegible] |

On the basis of 60 miles per day the operating cost amounts to $11.40.

## Measuring Sludge Depth in Deep Sedimentation Tanks

An ingenious method of measuring the depth of sludge in deep sedimentation tanks is employed at the sewage disposal works of Fitchburg, Mass. The measurements are made by means of a pitcher pump and 28 ft. of 1-in. rubber hose, marked in 1-ft. lengths. The pump is screwed to a 3-ft. plank and attached to the hose by a union coupling. In making measurements the plank is placed across the top of a gas vent and the hose pushed into the tank until it is near the supposed sludge level. The hose is then lowered 3 in. at a time. Between each shift sufficient pumping is done to insure a complete change of water in the hose. When the sludge level is reached the pump will raise sludge. The length of the hose below the chimney top is then noted and as the distance from top of chimney to bottom of tank is known, it is an easy matter to calculate the depth of the sludge.

## Four Years' Operating Results of Minneapolis Water Purification Plant

Interesting data on the first four years' operation of the purification plant of the Water Department of Minneapolis, Minn., are given by Mr. F. W. Cappelen, City Engineer, in the Transactions of the American Society of Municipal Improvements. The plant was put in operation Jan. 10, 1913. It consisted of 12 filter beds, each of 4,000,000-gal. maximum capacity, with two coagulation chambers, each of 1,300,000-gal. capacity. During the year it was found that the coagulation basins were not large enough, and also that the filter capacity had to be increased. This work was completed, in 1915, by adding four filters, each of 4,000,000 gal. maximum capacity, and two coagulation basins, each of 1,500,000 gal. capacity. In 1917 construction was started on eight filters, giving a total of 96,000,000 gal. which will be in operation this fall.

TABLE I—FILTRATION DATA.

| |
|---|
| [illegible] |

The accompanying tables from the Transactions give comparative figures for 1913, 1914, 1915 and 1916.

TABLE II—COST DATA ON PURIFICATION.

| |
|---|
| [illegible] |

**Filtration Data.**—Table 1 shows that the greatest total amount of water filtered during any one year was in 1916, with a total of 10,719,959,000 gal., an increase of 1,344,278,000 gal. over 1915. The average daily amount of water filtered during 1916 was 29,289,500 gal., an increase of 3,602,500 gal. per day over the 1915 average. The maximum amount of water filtered during any one month was in July, 1916, with 1,203,628,000 gal. and the maximum amount filtered during a 24-hour day was 58,929,000 gal.

TABLE III—NEW CONSTRUCTION COST.

| |
|---|
| [illegible] |

The average number of filters in service during 1916 was 15, as compared with 13 in 1915. The rate of filtration was reduced to an average of 2,100,000 gal. per day in 1916 for each filter, or to a rate of 80,000,000 gal. per acre of sand surface per day. This would be 64 per cent of the normal rate of filtration for which the filters were constructed, 125,000,000 gal. per acre per day. The additional filters in service during 1916 also caused an increase of 20 per cent in the length of filter runs and a decrease of 10 per cent in the amount of wash water used for 1915.

**Cost Data on Filter Plant Operations.**—The amount of alum used in 1916, while greater in total amount because of the greater amount of water filtered, was 3.4 per cent less than the amount used in 1915, if we consider the number of grains of alum per gallon of water treated. The cost of alum per 1,000,000 gal. of water for each of the four years was as follows: 1913, $4.66; 1914, $4.11; 1915, $3.47, and 1916, $4.25. The increased cost for alum in 1916 was due to the European war, the price of alum having advanced approximately 37 per cent. A large stock of alum carried over from 1915 helped to keep down the alum cost for 1916.

Hypochlorite of lime had been used for sterilization from the time the filtration plant was put in operation until Dec. 6, 1915. At that time it was replaced by liquid chlorine, due to the scarcity and high price of hypochlorite, caused by the war.

The cost for sterilization in 1916 was $0.27 per 1,000,000 gal., as compared with $0.21 in 1915. If hypochlorite had been used in 1916 the cost would have been fully 1,000 per cent greater for sterilization, the price of hypochlorite having advanced from $0.015 to $0.20 maximum per pound in 1916. A stock of 5,640 lb. of hypochlorite of lime which was left over when the liquid chlorine treatment begun was sold by the purchasing department at an average price of $0.112 per pound, a net gain to the city of approximately $0.09 per pound.

TABLE IV.—TYPHOID FEVER STATISTICS.

| | Number of Typhoid Cases | Number of Typhoid Deaths | Death rate per 100,000 pop. | Remarks. |
|---|---|---|---|---|
| 1900 | 376 | 79 | 38 | |
| 1901 | 630 | 121 | 58 | |
| 1902 | 320 | 66 | 29 | |
| 1903 | 720 | 95 | 39 | |
| 1904 | 738 | 103 | 41 | |
| 1905 | 269 | 62 | 23 | |
| 1906 | 252 | 97 | 34 | |
| 1907 | 181 | 77 | 26 | |
| 1908 | 104 | 51 | 17 | |
| 1909 | 95 | 59 | 19 | |
| 1910 | 1252 | 173 | 57 | Chlorination begun Feb. 1910 |
| 1911 | 299 | 36 | 11 | |
| 1912 | 186 | 37 | 11 | |
| 1913 | 136 | 41 | 12 | Filter Plant in operation Jan. 10, 13 |
| 1914 | 278 | 38 | 12 | Pop. 343.460 |
| 1915 | 166 | 25 | 7 | Pop. 353,460 |
| 1916 | 181 | 21 | 58 | Pop. 363.460 |
| | | | | |

There have been no complaints of odors or tastes in the filtered water due to the sterilizing agent since the liquid chlorine treatment was installed. The Wallace & Tiernan chlorine machines have given very satisfactory service.

The total cost per 1,000,000 gal. for purification of the water was $9.18 in 1913; $9.40 in 1914; $8.38 in 1915, and $8.90 in 1916. The cost for 1916 shows an increase of 6.2 per cent over that for 1915, the chief increase in unit costs being for coagulant and sterilizing agent, which advanced in price in 1916. There were decreases in the year from a maximum of 224 parts per million to a minimum of 80 parts.

The average total hardness also has remained practically the same. It varies from 248 parts per million to 82 parts during the year and averaged 165 parts per million for 1916.

Free carbonic acid in the filtered water showed an average of 10 parts per million in 1916 as compared with 12 parts in 1915 and 18 parts in 1914 and 1913.

**Typhoid Fever Statistics.**—Table IV contains typhoid fever statistics for Minneapolis for the years 1900 to 1916. It is interesting to note that the typhoid death rate has remained practically the same since 1911, the year following the installation of the hypochlorite of lime treatment of the city water supply, until the year 1915, when it dropped to 7 per 100,000. In 1916 there was a further drop in the typhoid death rate to 4.7 per 100,000, the lowest for Minneapolis of which there is any record.

# Experiences at Omaha in Use of Metalium for Pipe Joints*

BY HOMER V. KNOUSE,
Construction Engineer, Metropolitan Water District of Omaha.

The management of the Omaha water plant, some years ago, began seeking a substitute for lead, and as a result, experimented with a metalloidal composition or alloy known as metalium. The advantages claimed for this material are the following:

1. Low cost. To compete with metalium as a joint filler lead would have to sell at approximately 2 to 2½ ct. per pound.

2. Low melting temperature. This is a little more than one-third that of lead, resulting not only in a saving of fuel but also eliminating all danger from explosion in pouring a wet joint.

3. A relatively high specific heat. This insures with greater certainty the complete filling of a joint, and enables joints to be poured successfully at a considerable distance from the melting pot.

4. A low specific gravity. This is about one-fifth that of lead. Thus a man can easily handle a bucket of molten metalium sufficient to run a 48-in. joint.

5. No calking required. This eliminates the expense of calkers and the digging of bell-holes and also materially expedites the work of installing pipe lines.

6. The automatic closing of leaks developing in metalium joints. Initial leaks gradually close and those due to subsequent settlement of pipe eventually terminate likewise.

After a number of trials, it was concluded that these claims were substantially justified, and metalium has been utilized, to the exclusion of lead, in the installation of all pipe lines within the Metropolitan Water District for the past four years or more.

Joints of all sizes of pipe have been run, from 3 in. to 48 in. in diameter, and during the period in question in the neighborhood of 50 miles of pipe lines have been installed in the Water District, subject to pressures as high as 115 lb., using metalium alone as the jointing material. In the care of pipe of larger diameters than 24 in., however, a bestolyte lining is inserted before the metalium is poured.

While metalium possesses a number of advantages over lead as a jointing material, yet its adoption entails one disadvantage that should be realized and understood by any one contemplating its use. This disadvantage consists in the initial leakage that often takes place in metalium joints when the water is first turned on. In a lead joint, this leakage is obviated by calking, while in the case of a metalium joint, the pressure is left on with the result that calking is accomplished automatically, it being simply a matter of time. This self-calking is not merely an accidental result, experience having demonstrated it to be positive and certain in character.

Although this disadvantage, therefore, is apparent rather than real, it can readily constitute a real obstacle to the adoption of metalium in the mind of one contemplating its use, due to the fear that such inital leaks will not close. However, experience soon dissipates this fear and begets full confidence, so that ultimately there is no hesitation to cover a pipe line as rapidly as joints are run, which is unvarying practice in the Metropolitan Water District.

The following test illustrates this self-calking quality: After a newly laid pipe line was filled, the valves at each end were closed, and the line supplied with water through a ⅝-in. meter. The first reading indicated a leakage of 1,790 gal. per mile in 24 hours per inch of diameter of pipe; two days later this leakage was 564 gal.; five days later it was 174 gal.; one day later 139 gal.; two days later 115 gal.; three days later 85 gal.; and at a subsequent reading of the meter, the line was practically tight. In this connection it should be remembered that authorities are not wanting that decree a lead jointed pipe line tight when the leakage does not exceed 300 gal. upon the same basis of measurement. A mile of 24-in. pipe, which showed a considerable initial leakage when first put into service, was subsequently tested and found to be practically bottle tight.

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*From Journal of American Waterworks Association.

Again, the accounting department of the Metropolitan Water District affords monthly statements of water passing through all consumers' meters, and these statements show that more than 83 per cent of the water supplied to the city of Omaha (Normal meter inefficiency) is accounted for through such consumers' meters, and this notwithstanding the fact that there are still about 500 flat-rate services in use and also 600 sewer flush tanks unmetered. The estimated water used by these unmetered services, together with that used in building, for street flushing and sprinkling, the flushing of sewers and water pipe trenches, and the water required for fire service, is estimated at 5 per cent, thus making the total water accounted for 88 per cent of that supplied to the District. When it is remembered that some water systems cannot account for more than 60 per cent of the water supplied, it suggests that the mains of the Metropolitan Water District are reasonably tight.

Metalium is of a dark greyish luster, and is supplied commercially in globular form, put up in bags of 100 lbs. each. In use, it is melted and poured just as in the case of lead. However, while the temperature of molten lead when poured is immaterial, in the case of metalium the temperature is important; it must not be too hot. It is not difficult to tell when metalium is ready to pour, as it is then a thin, nearly black, oily appearing liquid. If too hot, molten metalium is inclined to thicken and does not pour readily. The difficulty of firing the ordinary lead furnace so as to limit the temperature renders it unsuitable for metalium. However, if the grate area of such a furnace is choked down with fire brick and clay so as to leave the open surface but 8 in. in diameter, such a furnace can be utilized. But the best plan is to secure the specially designed metalium furnace, as it is light, cheap, and admirably arranged for temperature control. It is surprising the small amount of fuel required—either coal or wood. In the Water District work old discarded lumber is chopped up for this purpose.

Furnaces using oil or gasoline are also satisfactory but are difficult to keep going in a high wind. It is very important that the bell and spigot of the joint to be run should be thoroughly clean and free from oil or grease. For this reason unoiled jute yarn, only, should be used for packing. Tarred yarn or yarn that is not free from oil or grease must be avoided. As a matter of fact, practically all initial joint leakage can be obviated if particular care is exercised in cleaning and keeping clean, each bell and spigot, using a putty knife to remove all lumps and blisters in the pipe coating. One of the Water District's most successful foremen does this, and after the joint is yarned, he inserts a loose strand of yarn so as to keep the joint free from dirt until poured, a practice that will be found highly profitable in connection with lead joints.

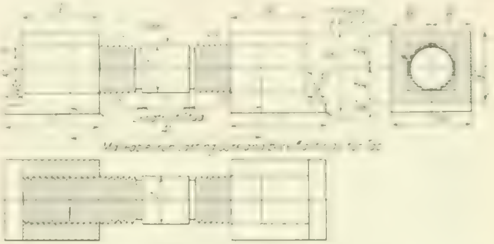
Any form of joint runner can be utilized, smearing it with wet clay before placing it around the pipe. The gate must be made larger than for lead and should be at least 6 to 8 in. high above the spigot. In the Metropolitan Water District work, clay is the material used for making gates in jointing pipe. In this connection, a round wooden gate peg is very useful. This peg is conical in form, 10 in. long, 2 in. in diameter at the bottom, and 3 in. at the top. The bottom of the peg is inserted between the ends of the joint runner where they come together to form the gate, then clay is built up about this peg, which is then turned around once or twice and withdrawn leaving a well formed gate of the right height.

The metalium gate buttons can be remelted, but it is important that they should be thoroughly cleansed and broken up before being put back in the melting pot.

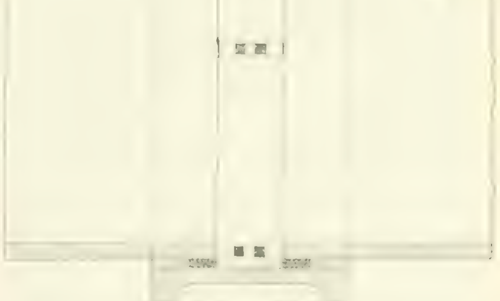
From the foregoing, it is evident that the technique of this jointing material is simple, and it can be easily mastered by the ordinary workman; moreover, when faithfully carried out, it will afford highly satisfactory results. However, it should be remembered by those contemplating the use of metalium, that they will arouse the resentment of the calkers, for the very good reason that the adoption of this material means their practical elimination. This was the experience in Omaha. Every calker at once insisted that metalium was a failure, and tried to make it a failure, even going so far as to throw dirt surreptitiously into the joints ready to pour. Failing in this, they sent their friends to the Water Board with warnings as to the dangerous innovation that was being attempted. All this, now, of course, is past and gone, so far as the Metropolitan Water District work is concerned, but others attempting to use this material will probably meet with the same experience, as human nature is the same the world over.

## Sleeve Spacer Facilitates Repair of Large Water Mains

In repairing mains 15 in. in diameter and larger, where such work necessitates the employment of a sleeve, the Water Division of St. Louis, Mo., has found it expedient to employ a special device known as a sleeve spacer. This device, developed by a local street service foreman, has proved of great value in such work. The spacer is a sort of turn-buckle affair, which is slipped into position and tightened, so as to prevent movement of pipe when the sleeve is slipped into place, but it serves an ideal purpose in spacing the sleeve so that an even joint can be run around the pipe circumference. Usually four of these spacers are employed in the repair of mains 30 in. in diameter and larger. It is particularly useful where repairs are made in close proximity to a valve and its subsequent closing with its large pressure surface may cause a creeping of pipe at the space where sleeve has been employed. We are indebted to William A. Foley, Principal Assistant Engineer, Distribution Section, for the accompanying drawings and information.



Details of Sleeve Spacer.



Method of Placing Spacer

# Methods of Locating Leaks in Underground Pipes*

By DAVID A. HEFFERNAN.
Superintendent of Waterworks, Milton, Mass.

There are several methods for locating leaks. The old-fashioned test-pit scheme is as good as any, provided that the system is well equipped with gates. The test-pit is nothing more than a manhole of convenient size built around a valve. On either side of the gate and within the manhole taps are made and corporations inserted. This furnishes the foundation for a by-pass around the gate. In the by-pass a meter is set, its size dependent on the consumption of the district to be tested. If the section is a large one necessitating larger than a 2-in. meter, it is well to make a supplementary by-pass with smaller meter around the large one.

The section to be tested should be carefully laid out, all gates located beforehand to eliminate delay and tested for tightness. The test for a leaky valve is simple. Close the gates to be tested and open a hydrant on the line between, removing the suction cap. Then open one valve slightly until the water in the hydrant rises to the level of the suction nozzle and just flows out. Then close the valve again. If the water continues to flow out, one of the valves must be leaking. Of course, for a few minutes, the flow might be from the houses in the district. But this should stop shortly. If the level of the water lowers, it shows a leak somewhere in the cut-off section below the level of the hydrant nozzle; but it would indicate a good-sized leak as the open hydrant removes all pressure from the line. Aquaphones may be used on each gate as further tests of tightness. The best hours for the actual testing are from 1 to 4 a. m. when the flow is less than at any other period of the 24 hours.

If all the gates are tight, it is evident that no water can enter the section so cut off unless it passes through the meter on the by-pass. If readings are taken at set intervals and gate by gate the area of the section covered by each test-pit lessened, it can be seen with ease that the leak will be discovered to be between a certain pair of valves. After its general location has been determined, in this manner, the exact point where the water is escaping may be found by looking for any luxuriant growth of vegetation by the side of the road, by the dampness on the surface of the street, by driving down a bar and noticing any moisture on removing it, by means of an instrument magnifying the hissing sound of escaping water or by using any other convenient method. In this manner a whole city or town may be covered.

The instrument just mentioned is contained in a small, light box. A small 4-leg brass table is set on the ground over the pipe in the vicinity of where the leak is supposed to be. The box has a raised bottom so that it may be placed over the table to keep out foreign noises. On the table is a microphone-detector with wire connection to an amplifier battery contained in the box. Very sensitive ear receivers are wired to the battery. When the instrument transmits a rushing noise to the ears it is evidence that the leak is close at hand. The affair is set at different points along the pipe line until the point where the noise is loudest is reached. The leak will be found directly under this spot. Used in connection with a wireless pipe locator it will be found to be satisfactory.

The beauty of the test-pit method is that it is permanent; the pits are always ready in time of need. If it is not desired to construct the manholes, the same results may be obtained by connecting two hydrants with fire hose, one hydrant being inside the district and the other outside the district to be tested.

Another method, quite as accurate, is the use of the pitometer. There are also the caustic soda method, and a special device which makes use of water hammer. This works on the principle that the sudden closing of a valve produces an impulse which travels through the water in a wave, decreasing in intensity in passing an opening in the pipe. It is claimed that the relative distances from the instrument to the break and to the suddenly closed valve is readily determined.

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*From a paper presented Sept. 10 before the New England Waterworks Association.

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# How Priority Orders May Be Obtained by Public Utilities

Municipalities and public utility companies are experiencing much difficulty in securing materials for operation, maintenance and new construction. The general policies of the administration regarding this situation is outlined as follows in the September Journal of the American Waterworks Association:

Cities and utility companies must remember that when President Wilson told us to "give until it hurt," in order to bring the war to the earliest possible completion, his appeal was to communities and corporations as well as to individuals. The general policies which are rapidly going into effect in Washington are based on this thought, that communities must give their aid by deferring to a later day all unessential work. The difficulty is to determine what is essential and what unessential, but the War Industries Board has made enough rulings to throw light on its position in regard to the prosecution of various classes of work.

In maintenance and repair work, necessary for the upkeep of plants furnishing essential service to communities, the War Industries Board grants every assistance in its power. It cannot accomplish an impossible task, however. There are some sections of the country where important war time orders call for every barrel of cement that can be furnished by mills normally supplying that district, and the United States Railroad Administration does not favor shipments from abnormal sources of supply for a district. Every pound of steel that can be turned out of our furnaces is needed for war-time purposes, just now. Not long ago a branch of the War Department was so hampered by lack of steel that it sent out representatives to comb the jobbers' stocks and blacksmith supply houses in a large section. Pig iron is needed for many war purposes the civilian knows nothing about. In some sections north of the Potomac and Ohio and east of Indiana, the railroad congestion is so severe that important branches of the Government are placing no orders there for the present. In short, the Government is experiencing great difficulty in securing materials to win the war, and consequently the managers of water works must not expect anything else.

While there is a general agreement that existing public utilities should be maintained in an efficient condition, there is very little probability that new construction will be possible. A suburb which has gone without water mains or sewers until now can probably go without them a year or so longer. A water plant which has been furnishing unfiltered water for some years probably cannot make an effective plea before the Washington authorities that an unsanitary condition exists which demands immediate relief. A water department in a city where the growth has been only normal will probably experience much difficulty in securing materials for new dams or pumping stations, for the federal administration is not hesitating to put the country on short rations even of essentials in order to back most effectively our lads on the battle grounds and high seas. Everybody agrees that water of unquestionable purity and ample quantity is most desirable, but our soldiers and sailors are sometimes going without it and we can learn, as they do, to be careful of what we have.

In short, then, no water works manager should attempt to obtain materials which are not absolutely necessary to maintain his plant in its present condition, unless the new extensions are absolutely necessary for war-time industries. Every day thousands of letters praying for relief of one kind or another reach Washington, and the claim made for the relief is that the community or the district is engaged in war work very largely. Such petitions are never granted, for generalities are not accepted as evidence in Washington. Every application for relief must be accompanied by positive proof that if the application is not granted the active prosecution of the war will be checked, a heavy previous investment will be seriously impaired, the health of a large number of people who cannot be moved elsewhere will undoubtedly be placed in grave danger, or a large financial loss and great inconvenience to many persons will arise from stopping construction undertaken before the beginning of the current year.

In each case it is absolutely necessary to explain what alternative remedies have been considered and why they have been deemed inferior to that requested. The statement that larger mains must be laid to meet the needs of a growing population in any section of a city is worthless as an argument at Washington. There should be a map of the section of the city, showing the location and size of the mains serving it, records of the water pressure at different points if this is important, a statement of the number of consumers, and an explanation of what the water department is doing to prevent water waste. In short, there must be just as complete a technical and administrative demonstration of the soundness of the appeal as a bank demands when it receives an application for a loan. This application should be sent to the Priorities Division, War Industries Board, Washington. Do not send a delegation or even a single representative and above all do not ask a member of Congress to help, for he cannot do anything that a proper application by mail will not accomplish better and more quickly. Applications for relief should be made out on forms which can be obtained from the Priorities Division, with instructions regarding their use.

# Methods of Handling Frazil Ice at Hydro-Electric Plants

Useful suggestions for handling ice troubles at electric plants are given by Mr. J. A. Walls in a bulletin of the National Electric Light Association. An abstract of the article follows:

The method of reducing or eliminating service troubles from frazil or anchor ice that enters power house intakes requires two steps: one aiming at an early diagnosis of a probable or imminent ice attack, and the other comprising all action taken to put the plant equipment and the whole operating system in the best shape to meet the attack, and also to free the plant of ice that has actually formed on important parts of the equipment, notwithstanding all precautions.

**Early Diagnosis of Impending Ice Attack Important**—When frazil ice actually passes through the plant there are so many things to be looked after constantly that the half-hour or so that may be gained by a fore-knowledge of the incipient stage of ice formation is most valuable for getting everything in readiness, including, of course, the human element. If, in a frazil ice attack the ice is once allowed to accumulate beyond a certain point, the battle is lost. Early diagnosis is most important.

A thorough understanding of the nature of frazil and anchor ice, and of the atmospheric conditions (differing in various climates) that favor such ice formation and determine the time of onset of ice difficulties, should be disseminated among all members of the operating force.

Frazil ice is formed during cold weather and high winds in the absence of any protective ice coating on the lake. Under such conditions the water becomes super-chilled. Ice needles then appear and by sticking to the racks or turbine parts choke off the water from the turbines or prevent the operation of the turbine gates. Ice thus formed persists in the lake until a rise in temperature of the water (due generally to sunshine) and a decrease in the winds result in melting the needles or allow them to form a surface sheet of ice. Dull and windy days with little prospect of the sun's rays piercing through the cloudy sky aggravate the difficulties. At the Holtwood plant frazil and anchor ice have never formed when the storage pond (reaching about 8 miles up-stream and bounded at the head by rapids) was covered by a ptrotective ice coating, but they are to be expected at the beginning of the first cold spell in winter, before the protective ice coating on the lake has formed, or during the winter or towards spring after a run of up-river ice or thaw has carried out the lake ice and before a renewed cold spell produces another protective coating.

Anchor ice is formed when there is no ice covering on the lake, or only a thin sheet of clear ice, on a cold night, when the sky is clear. The anchor ice then forms on the bed of the river and is detached therefrom in huge masses of slush-like material when the water temperature is slightly raised, usually a little after sunrise.

**Methods of Detecting Onset of Frazil Ice.**—Assuming the existence of conditions favoring an on-set of frazil or ground ice, the operators watch for its appearance. The specific means of early detection employed are as follows:

A test chain, immersed in the flowing water of the forebay, is examined every half hour or at more frequent intervals for evidences of ice.

A graphic thermometer with a large scale around the zero point records the temperature of the water. Frazil or anchor ice cannot form until the water reaches freezing temperature.

Frazil ice forms easily on metal exposed to flowing water, particularly on fine screens. One of the auxiliaries at the Holtwood plant is a 50-hp. turbine that receives its water through a 14-in. penstock, protected by a fine-mesh iron screen. This turbine drives a plunger pump through gear reduction. The intake screen invariably becomes choked with ice long before any other apparatus in the power house shows signs of ice. The turbine-driven pump at first slows down and sometimes comes to a sudden stop. Sometimes a rumbling noise in the turbine casing accompanies the decrease in speed. Whenever atmospheric and other conditions look favorable for ice formation this turbine driven pump is operated continuously at a fixed valve opening, and as it is placed in the pump tunnel within hearing distance of an operating attendant, it serves, through the variation of the gear noise with the speed, as an acoustic signal for the indication of imminent ice trouble.

**Protecting Features.**—Naturally, a plant can be protected more effectively from operating difficulties due to ice when this object has been kept in view from the start. Some of these protective features to be considered in the original design of a plant are as follows:

Enclosure of gate house and provision for heating it, such as letting the warm air of the generator room enter it or in high-head plants by heating it artificially. In case this is done by electric heaters the amount of energy required is relatively small if proper provision is made for circulating always the same air and directing it into the head gate channels and above the screens, where the warming of half submerged metal parts is most effective. Depending on the number of screens, correspondingly quick means of removing them on short notice should be provided; quick lowering of head gates should be insured under all conditions.

Frazil ice chokes up at first the small spaced openings of screens and then the guide vanes or runners of the smaller water wheels. None of the important auxiliaries, therefore, should depend solely on water-wheel drive. This refers to the small water wheels that are used for driving exciters, governor or hand-control pumps, and other station service apparatus. Sufficient spare capacity must be provided by alternating-current driven exciters or under severe conditions even by separate steam or gasoline prime movers, always to insure station light and power for the operation of cranes, lubricating pumps, governor auxiliaries, air compressors, etc. An emergency storage battery is highly desirable to tide over any temporary trouble with the alternating-current or turbine-driven exciters.

That type of turbine installation exposing metal surfaces to the warm air on one side and to the ice-bearing water on the other side, is better suited to withstand a long ice run without appreciable reduction of capacity, than the type of turbine installation where the turbine parts are pretty thoroughly heat insulated from the warmer portions of the power house, i. e., where, for instance, the turbine parts are set in concrete pits and have only a small heat conduction cross-section connecting the submerged turbine parts to the warm air of the power house. In any event, conditions can be still further improved if hot air taken either at the top of the generator room, or artificially produced, is directed by a blower, or by a natural ventilation as close as possible to the water exposed parts of the turbine installation.

Notwithstanding all precautions, it may be possible that a water wheel is rendered inoperative by the accumulation of ice in the runners, in guide vanes, or around the operating mechanism, which may be rendered immovable by the freezing of a solid mass of ice around it. In the natural course it would probably be many hours or several days before such a disabled unit could free itself from ice, and only the introduction of outside heat would bring it back to service in a reasonably short time. It would be bad practice to permit a unit to freeze to such an extent that its output is reduced to almost nothing, aside from the great danger of a "runaway" if it should get beyond control. The thawing out of the ice will take a disproportionately longer time than the possible benefit obtained in this case by the continued hanging on of the unit to the load at a gradually reducing output. It is much easier to restore to service a unit that has suffered only a moderate accumulation of ice and that can be freed comparatively quickly by the application of steam. Depending on the climate and on the nature of the turbine installation, more or less extensive provision should be made for admitting heat, preferably in the form of steam, to the interior of the turbines. If such provisions are made from the beginning, little valuable time is lost in the getting up of steam and admitting it to the turbine pits in advance of the actual ice trouble during the early morning hours when the load, in most plants, is below the station capacity. The switching over of steam from one unit to another can be done quickly during the actual ice run.

It would be interesting to determine the benefit derived from providing heat by steam jackets around guide vanes and above runners and other vital points.

## Increase of Waterworks Operating Expenses and Readjustment of Rates

Information on operating expenses and rate increases of some of the leading water plants of this country was collected last spring by Mr. F. C. Jordan, secretary of the Indianapolis Water Co. Replies to his letter of inquiry received up to June 10 last showed an average increase of 29 per cent in operating expenses during the previous six months over the normal pre-war operating expenses. This was the average for 32 plants. The highest increase (50 per cent) reported was that of Jamestown, N. Y. The lowest (15 per cent) was at Peoria, Ill.

Action during the past year or so regarding water rates was reported as follows:

Atlanta, Ga., reduced its discount for prompt payment from 25 to 10 per cent.

Cincinnati, O., increased its rates 25 per cent, this increase affecting all water consumers.

Dayton, O., increased its annual minimum on ⅝-in. meters from $4.40 to $6.60. This amount covers a quarterly consumption of 1000 ft. in addition to the meter rental.

Flint, Mich., increased the rate to its large consumers from 5 ct. per thousand gallons to 8 ct.

Brockton, Mass., increased its rates to all consumers.

Philadelphia, Pa., increased its metered water rates 30 per cent.

Richmond, Va., increased its rates to large consumers from 3¾ ct. per 1,000 gal. to 5 ct.

Detroit, Mich., put into effect an increase covering all consumers, and is now considering an additional increase.

Toledo, O., increased its water rates on Oct. 12, 1916, and is now figuring on another increase.

Savannah, Ga., increased its rates to all water consumers.

Toronto, Canada, increased its rates 10 per cent in 1917, and an additional increase of 25 per cent became effective in the early part of this year.

## Levee Construction for Drainage Districts

Interesting information on design and construction features of levees for drainage districts are given by Mr. Charles W. Okey, Senior Drainage Engineer, U. S. Office of Public Roads and Rural Engineering, in a bulletin, "The Wet Lands of Southern Louisiana and Their Drainage," issued recently by the U. S. Department of Agriculture. The following notes are abstracted from the bulletin:

The location of a levee influences its design, construction, and maintenance, as well as its usefulness to the district. Unlike levees along our rivers, those along the average reclamation district in this section have not been located according to the topographic conditions, but rather according to property or land lines. This has usually resulted in regularly shaped districts and minimum length of levee for area inclosed; but the cost of construction and maintenance per unit of length has often been much greater than if some attention had been paid to topography. Throughout most of the wet prairie there are winding bayous that have along them solid ridges of silt that average from 1½ to 2 ft. above general ground surface. In other places the bayous are filled in entirely, and there have been left ridges of silt having widths of from 200 to perhaps 1,200 ft., with the usual elevation of 2 ft. If the levee be located on a solid ridge, the material will be more stable and impervious and the levee can be made of less cross-sectional area than would be necessary if it were located in the soft prairie. Construction, also, will be easier and cheaper and the expense of maintenance much less. Where levees are to be built to protect areas of marsh land on the immediate coast line, a strip of land at least a quarter of a mile wide should be left as a foreshore to break the force of the wave. Where the exposure is particularly great, this strip of land should be wider.

If the levee be located on firm land and the land outside the levee never is flooded for more than a few days, it will, in some cases, be advisable to dig the canal from which material is taken for the levee on the inside of the district and to utilize this canal as a drainage channel. In such cases the berm should be especially wide, at least 20 ft. In general, this type of construction is not recommended. If the levee canal be placed on the outside of the district it can be utilized for navigation.

**Local Conditions Influence Design.**—The design of the levee will depend largely on local conditions. Its top should be from 2 to 4 ft. above the highest stages of water in the surrounding lakes and bayous, depending on the area of land protected and the probability of previous high-water marks being exceeded. Where the water to be kept out is due to storm tides in the Gulf, the height of the levee should be determined only after very careful investigation of all surrounding conditions has been made and the probable highest stage estimated. If the levee is located in an exposed locality its top should be about 4 ft. above the estimated highest water. A minimum height of about 4 ft. should be used through the soft prairie section, as anything less is not likely to prevent seepage satisfactorily; for when located on a ridge the water will stand against a levee only for short periods, while if located in a soft prairie the water will be in continuous contact with the lower foot or two of the levee. In places exposed to strong wave action, the height should be sufficient to provide for the break of the waves; in addition, some provision should be made for protecting the levees from their erosive action. This protection could be secured by planting willows some distance in front of the levee.

Where the levee is located on a ridge the top width may safely be made 4 ft., with side slopes 2 to 1. A levee of this type is often built with wheelbarrows, and although the unit cost for this method is quite high, being about 18 ct. per cubic yard, the total cost is considerably less than if the work were done with the usual floating dredge. Yard for yard, the dredge would, of course, handle the material much cheaper, but the excavation would be more than would be necessary for the levee. This objection would be overcome if the dredge were building a levee along the bank of a bayou of sufficient depth to float the machine, or if a reservoir canal were being excavated within the district, the waste bank to be used as a levee.

Where the levee is located in the soft prairie the top width should average about 6 ft. The slopes should be about 3 to 1; in fact, if the material is very soft it will not take a much steeper slope than this during construction. As the material always becomes more stable after being placed in the levee, no trouble should be expected from slides after it begins to dry in place.

The berm along the base should be at least 15 ft. wide. Where the soil is exceptionally soft this should be made as much wider as practicable, at least 20 ft. The width of berm will of course depend somewhat upon the nature of the machinery used in construction.

**Construction Methods.**—Some type of floating dredge should be used in the construction of most levees. In heavily timbered sections, or where old submerged stumps are numerous, the dipper dredge will work to the best advantage; but in the open, grass-covered prairie, the orange-peel-bucket dredge has many advantages. Owing to the longer boom and narrower hull, the latter type of dredge is able to leave a wider berm along the toe of the levee. . It also is better able to sort the material placed in the base of the levee; for the top layer of muck can first be taken out of the canal, and then the silt underneath, while the dipper dredge will usually cut up through both the silt and the muck and mix them. The levee should usually be constructed in several layers, for both the base and the material are likely to be so soft that subsidence will be too great if a height of more than a few feet is attempted. This yielding of the base will often cause the side of the canal to cave, especially if the berm be small.

The total subsidence and shrinkage of the material in the levees often amounts to 50 per cent, and in special cases is as great as 80 per cent of the bulk of the material, as measured in excavation. Practically all of the subsidence and a part of the shrinkage takes place during construction, so that the remaining change in height can be taken care of by maintenance. When a large percentage of muck is placed in the levee the shrinkage will be great for a number of years, due to the decay of the vegetable material in the muck.

The orange-peel bucket is especially suitable for placing several layers in a levee. After a canal is once cut in the soft prairie a considerable depth of soft mud that makes very poor levee material will be in the bottom. The dipper dredge, when working in such a canal, will place a large percentage of soft mud in the levee; while an orange-peel bucket, when dropped forcibly, will penetrate the undisturbed silt below and fill with it, the soft mud running off when the bucket is raised.

If the side of the levee is along a solid ridge above ordinary water level, no special precautions need be taken to prevent seepage, although all stumps and logs should be removed from the site and a shallow ditch should be cut to insure a perfect bond between the ridge and the levee. On the other hand, if the levee is through very soft prairie, the material dropped from the dredge will penetrate the muck and form a good bond with the underlying silt. It is on the portions where the muck is thick and turfy in character that particular pains must be taken. A ditch cut along the center line of the levee before the dredge starts working is of no special benefit, as the material placed back in the ditch by the dredge will be largely muck, although it is true that this treatment will break the continuity of the muck and help to cut out a portion of the seepage. A better plan is to wait until the first layer of material has been placed by the dredge and then cut a ditch along the toe of the slope of the levee opposite the dredge and refill it with impervious silt dredged from the bottom of the canal. This will insure a good bonding of the material and is a necessary part of the construction. At times old muck-filled bayous will be encountered which must be closed with levees. In such cases the quickest, and quite often the cheapest, way to insure that the levee hold its grade line is to drive two rows of sheet piling across the bayou at the proper spacing. These rows should be tied together with rods and the fill made between them.

**Cost of Dredge-Built Levees.**—The average unit price for dredge-built levees, where the material is measured in excavation, has been from 6 to 8 ct. per cubic yard, depending on the amount of timber and stumps encountered. Large amounts of such work have been done at an actual cost, to the owners of the dredge, of less than 3 ct. per cubic yard. Since it requires from one and one-half to three times as much material in excavation as finally appears in the settled embankment, the contract price would vary from 10 to 25 ct. per cubic yard of such embankment.

If the levee is to be brought to a regular cross section by hand or machine work, a small additional charge should be made. In general, however, the levees, as built, have not been surfaced after the dredge work is finished, although it would be better if the levee were smoothed off, seeded to Bermuda grass, and pastured. This will aid in closing up the cracks that form through the gradual shrinking of the material. In certain cases it may become necessary to plow and harrow the levee in order to close up these cracks. If this is not done, and if a rapid rise of the water outside the district occurs after a prolonged dry period, the seepage through the body of the levee will be very great. In certain cases this seepage through shrinkage cracks has overtaxed the capacity of the pumping plant. The grazing of the levee provides a cheap and profitable method of maintenance and will discourage the action of burrowing animals.

# Recent Developments in City Manager Field

The following notes on the activties in a field that offers many opportunities to engineers are published through the courtesy of Mr. H. G. Otis, Secretary City Managers' Association. The notes were prepared by Mr. Otis for the National Municipal Review, the official organ of the association.

The three candidates for positions on the first commission under the new commission manager charter, of Griffin, Ga., nominated in the primaries held Sept. 26th, are among the best and most public spirited business men of the city. These men were selected by a somewhat unusual procedure which augurs well for the success of the new plan. A general mass meeting was held at the City Hall, September 18th. A "straw vote" was taken and those receiving the three highest totals were declared the candidates of those present at the meeting. When these three candidates entered the primaries referred to, they received the overwhelming majority of the votes cast. In Georgia the nominees of the democratic primary are certain of election at the succeeding general election, held in December. The nominees are J. W. Gresham, a prominent manufacturer and ex-mayor; R. F. Strickland, a wealthy merchant-farmer-banker; B. B. Brown, a self-made business man of considerable wealth. A city manager will be selected in December to take office Jan. 1st. Griffin is the first city in Georgia to adopt the new plan. Its population is estimated at 10,300.

Edwin J. Fort was chosen city manager of Niagara Falls, N. Y., Sept. 16th. He succeeds O. E. Carr who was promoted to Springfield, O., Sept. 1st. Mr. Fort has served 11 years as head of the department of sewers, Borough of Brooklyn, N. Y. He is an engineer of wide reputation and has had considerable experience in municipal affairs.

George R. Belding has been appointed city manager of Hot Springs, Ark., to succeed Charles H. Weaver who recently resigned. Mr. Belding was at one time mayor of Hot Springs and has been serving as secretary for the local Business Men's League. Hot Springs is experimenting with the plan originally tried at Beaufort, S. C., of employing one man to fill the dual positions of city manager and secretary of its commercial organization, as Mr. Belding still retains his office as secretary of the Business Men's League. His salary will be apportioned between the city and the league.

Dr. W. C. Bailey, formerly president of the San Jose Chamber of Commerce, chairman of the Santa Clara Liberty Loan Committee, Red Cross Drive Committee and War Work Council, has been appointed city manager of San Jose, Cal., to succeed Thomas H. Reed. The vote stood five to two. The two voting in the negative stated that they had no personal objections to Dr. Bailey but did not believe that the city needed a city manager at present. A letter from Dr. Bailey states that he has entered the new profession temporarily only. It will be recalled that Mr. Reed resigned last summer to return to his work as professor of economics at the University of California as mentioned in the July Review.

Hubert A. Stecker, who has served as city manager of Charlottesville, Va., since Jan. 1, 1917, has resigned to enter the army service. His administration at Charlottesville has been most successful. His duties in the army follow very closely the work of a city manager. He has been commissioned captain in the quartermaster corps and placed in charge of streets, buildings and grounds at Camp Logan, Texas.

The U. S. Government is applying the principles of the city manager plan to many of its war-time enterprises. Announcement recently appeared in the daily press that the Government is seeking men to place in charge of war-work communities. The management of these communities will involve not only the collection of rents, the supervision of repairs and maintenance of buildings, but will comprise duties analogous to those of a city manager, including responsibility for sanitation, cleanliness, fire and police protection and the general health and welfare of the inhabitants. These managers will not be permanently attached to one community but will be transferred and promoted, thus creating a corps of trained experts in community management. Allan Robinson, manager of operating division, U. S. Housing Corporation, 613 G street, N. W., Washington, D. C., is in charge of this branch of the service.

A great many cities and towns throughout the country are considering adoption of city-manager government. Among these are: Aberdeen, Wish.; Ambridge and Blairsville, Pa.; Burlington and Davenport, Ia.; Daytona, Fla.; Enid and Pawnee, Okla.; Grand Mere, P. Q.; Lawrence, Mansfield and Wellesley, Mass.; New Haven, Conn.; St. Paul, Minn., and Suffolk, Va.

E. A. Beck, who has served as city manager of Goldsboro, N. C., since the new plan was put in operation July, 1917, has been commissioned as captain in the Army's Sanitary Department and is stationed at Fort Oglethorpe, Ga. Mr. Beck's work has received most favorable comment and the local paper suggests that in time he will be recignized at deserving a statue in the public park. It will be recalled that Mr. Beck was selected from a field of 522 candidates for the position of manager at Goldsboro. Prior to his appointment he had served as manager and engineer for the Boroughs of Sewickley and Edgeworth, Pa. No successor is announced.

The fourth city manager of Beaufort, S. C., is Hal R. Pollitzer, who has been serving as acting-manager since the resignation of John R. Kneebone last spring. Mr. Pollitzer graduated from Clemson College, S. C., as a civil and electrical engineer. He has served for several years in the Beaufort organization, first as superintendent of public works, then as city engineer, and is well trained for the new position. His salary is $1,800.

**Meeting of New York Section Am. W. W. Assoc.**—The New York Section of the American Water Works Association will hold an informal dinner at 12:30 p. m., Oct. 16, at the McAlpin Hotel, New York City. The operation of water works under war conditions will be discussed. Edw. S. Cole, 25 Elm st., New York City, is Secretary of the Section.

## Personals

C. A. Jennings, manager of the Chicago office of Wallace & Tiernan Co., has been commissioned a captain in the Quartermaster Corps, Maintenance and Repair Branch, Construction Division, with headquarters at Washington. Mr. Jennings was superintendent of the Bubbly Creek Filtration Plant from its inception in 1908 until two years ago. His work at Washington will be under Maj. George A. Johnson, and he will look after water supplies and sewage systems at the various cantonments.

J. J. Collins has resigned as assistant engineer in the highway department of Baltimore, Md., to accept a position as assistant engineer in the sewerage and other underground work at Camp Meade.

C. W. Clark has resigned as superintendent of the city electric light and water plant of Bluffton, Ind., and has accepted a position as manager of the Standard Oil Co.'s electric plant at Carlinville, Ill.

Capt. David C. Morrow has been appointed chief utilities officer at Camp Pike, in which position he will serve as a sanitary engineer and will have charge of the sanitation of the camp.

J. J. Carment has been appointed city manager of Kamloops, B. C., at a salary of $3,000 per year.

## Obituaries

J. Murray Africa, a well-known engineer of Huntingdon, Pa., died Sept. 19, aged 55. He is survived by three sons, J. Murray Africa, Jr., now with the American Expeditionary Forces in France; Charles McKnight Africa, a student at the Van Rennssler Polytechnic, Troy, N. Y., and Hunter Africa, a student at Mercersburg Academy.

James P. Murray, formerly assistant engineer in the Texas Reclamation Department, died Sept. 28 at Austin, Tex. At the time of his death he was captain in the 472nd U. S. Engineers.

Joseph B. Hawthorne, a member of the railroad contracting firm of Dibble & Hawthorne, of Tacoma, Wash., died Sept. 25, aged 55.

William S. Edward, for 35 years city engineer of Portland, Me., died Sept. 26, aged 88 years.

Charles G. Roebling, President of John A. Roebling's Sons Co., Trenton, N. J., died Oct. 5.

Silas W. McCleary, a road contractor, of Lodi, Cal., died Sept. 21, aged 53.

Stephen J. Collins, a contractor of Rock Island, Ill., died Sept. 27, aged 68.

### Statement of the Ownership, Management, Circulation, Etc., Required by the Act of Congress of August 24, 1912,

of Engineering and Contracting, published weekly at Chicago, Ill., for October 1, 1918.

State of Illinois, County of Cook, ss.—Before me, a notary public in and for the state and county aforesaid, personally appeared Lewis S. Louer, who, having been duly sworn according to law, deposes and says that he is the business manager of Engineering and Contracting, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to-wit:

1. That the names and addresses of the publisher, editor, managing editor and business manager are:

Publisher—Engineering and Contracting Publishing Co., Chicago, Ill
Editor—H. P. Gillette, Chicago, Ill.
Managing Editor—C. T. Murray, Chicago, Ill.
Business Manager—Lewis S. Louer, Chicago, Ill.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock): H. P. Gillette, Chicago, Ill.; N. M. Rodgers, Chicago, Ill.; Lewis S. Louer, Chicago, Ill.

3. That the known bondholders, mortgagees and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in casse where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner: and this affiant has no reason to believe that any other person, association, or corporation has any interest, direct or indirect, in the said stock, bonds, or other securities than as so stated by him.

(Signed) LEWIS S. LOUER.

Sworn to and subscribed before me this 23d day of September, 1918.

(Seal.) C. E. MEINDERS.
(My commission expires June 7, 1920.)

*Railways and Gov't Works Monthly Issue*

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The four rotated special monthly issues and four quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year, but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the four special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering field. See advertising page for further information and subscription coupon.

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(a) Buildings (c) Ship Construction
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CONTENTS

Make Your Knowledge Militant ... [illegible]
Why Large [illegible] Poorly Managed ... [illegible]
Will Motor Truck Competition Revolutionize Railway Operation? ... [illegible]
The "Voice of God" as Heard by [illegible] ... [illegible]
Public Service Commission [illegible] Transit ... [illegible]
The Single Tax Theory and Government Price Regulation.... 357
Rail Creep ... [illegible]
Loading Rails with [illegible] at Cost of [illegible] Cents per Ton ... [illegible]
Comparative Costs and Results of Hand vs. Machine Tamping Ties ... [illegible]
Rules for Foremen ... [illegible]
Concrete Caissons of Trapezoidal Sections for Breakwater Construction ... [illegible]
Railway Ditching With Teams and Scrapers and With Steam Ditchers ... [illegible]
Proper Forming and Treating of Bits Increase Drilling Efficiency ... [illegible]
Street Car Fares Increased in 240 Cities ........................ 362
Labor Saving Appliances for Rail Renewing ... [illegible]
The U. S. Employment Service and Railway Labor ... [illegible]
Precautions for Handling Explosives ... [illegible]
Engineers Wanted for Construction Division of Army......... 366
Efficiency Tests of Rock Drill Accessory Equipment........... 367
Old Rails Used for Ties in Street Railway Track............. 368
Applications of Conveyors for Handling of Materials......... 369
Filtered Air Supply for Pneumatic Tools ... [illegible]
Selecting and Protecting Rope ... [illegible]
Precautions for Reducing Accidents on Construction Work.. 371
The Wages of Railway Technical Engineers.................. 371
Mines and Countermines on the French Front............... 372
Cleveland Considers Broad Reorganization of Its Railway and Interurban Transportation Facilities ... [illegible]
Separator for Removing Water from Compressed Air ... [illegible]
Gas Driven Locomotive for Industry Purposes............... 373

# Make Your Knowledge Militant

Engineers have long been given to exchanging opinions about the inertness of the public and the general failure to put to full use the technical knowledge possessed by engineers. Aside from the futility of such criticism, engineers would do well to cease complaining, for the time can be better spent in trying to effect a change in public sentiment toward engineers and engineering. To accomplish this end most efficiently, engineers must make their knowledge militant. They must fight aggressively to have their ideas adopted by the public and not merely present their ideas and plans mildly and as if it were no concern of theirs whether they are adopted or not.

Some years ago a business man told the writer that engineers, as a class, seemed to him sheep-like and lacking in aggressiveness. "Men of that type," he said, "never succeed greatly in doing anything that calls for initiative." Although his criticism was too severe, there was a measure of truth in it then, and there is still a measure—though a smaller measure—of truth in it yet.

A man intimately acquainted with that supremely aggressive individual, the late James J. Hill, at that time president of the Great Northern Ry., told the writer that Mr. Hill did not hold civil engineers in very high esteem, as a class. To illustrate his point he told the following story:

Mr. Hill's road had hundreds of miles of wooden trestles that were rotting out. He wanted the trestles filled with earth on certain divisions, and he asked his engineers for plans and estimates of the cost of doing the work in the most economical manner possible. He cautioned the engineers that, since the job was a very big one and would grow bigger, he expected them to make a very thorough study of the problem. About two weeks' later the answer to his question was given, and he was told that the best method would be to fill the trestles from large dump cars that had been loaded by steam shovels at gravel pits, and that the cost would be 15 ct. per cubic yard. Whereupon Mr. Hill called in the man who told this story to the writer and said: "Isn't this just like these fool engineers? I told them to study this problem thoroughly, yet they give only two weeks to the study of it! Then they come to me and hand me the old method of using steam shovels and cars throughout! Haven't they any initiative? Must I furnish brains for their work as well as for my own?"

In a great wrath Mr. Hill started to show his engineers that he was a better engineer than they. He went to California and there spent several weeks studying the excavation and conveying of earth in the placer mines by means of hydraulic giants and sluices. Then he returned and began experimenting with the same method for filling trestles with material sluiced from nearby hills by gravity, and pumped from low-lying ground. He ascertained that he could do most of the gravity sluicing of earth for 6 ct. per cubic yard and most of the pumping for 12 ct. per cubic yard. Thus James J. Hill taught his engineers that he was a better engineer than they, because he had initiative and was aggressive in his determination to beat the standard cost of 15 ct. per cubic yard for trestle filling.

The story is good enough to be true, and is doubtless true in large part. The man who told it was a lawyer and he took a deal of satisfaction in the telling of it. He finished by asking what the writer thought of "the old man" as an engineer. The writer replied that Mr. Hill had thus proven his right to be called an engineer, and a good one, except in one respect. If he had been acquainted with engineering literature, or even with the one American book on earthwork, he would have known that the hydraulic method of trestle filling was old before Mr. Hill re-invented it, and even older was its use in building earth dams. The writer added that he had noted with amazement the meagerness of the engineering library in the Great Northern offices at St. Paul and elsewhere. With even greater amazement had he learned the miserly salaries paid to the Great Northern civil engineers right up to and including the chief engineer. In those facts the writer saw, he believed, both the cause and the effect of which Mr. Hill had complained. Being without adequate respect for engineers, Mr. Hill neither provided them with an adequate library nor paid them adequate salaries. He himself deadened their ambition, and drove many of them out of the railway field. Hence, by as much as he had proved himself a good engineer in his re-invention of the hydraulic process of trestle filling, by that same test he had coincidently proved himself less than an ideal railway president.

While it is undeniably true that railway presidents and other executives often err through lack of respect for engineers and engineering, is it not also clear that engineers have erred through failure to demand and secure adequate respect for engineering science? Is it not patent that it is the duty of engineers, not only to their profession but to the public, to make their knowledge militant, to use every means in their power to spread the gospel of engineering as the economic salvation of mankind?

## Why Large Public Utility Companies and Railways Are Often Poorly Managed

As a company grows larger there is a tendency toward wider distribution of its stock among small holders who are able to give a little or no supervisory supervision to the managerial policies of the company. When eventually no single stockholder is devoting his time managing or carefully supervising the management of the company, almost invariably there follows a decrease in economic efficiency. This is a phenomenon that has never received the attention that it merits, for attention has been distracted by the profits that large companies usually make because of the economy of operating on a large scale.

American railways—both steam and electric—illustrate the point in question. Salesmen who try to sell office machinery and other labor saving devices to railway companies, as well as to manufacturing companies, are usually impressed by the difference in the attitude of the men they meet in railway offices and in manufacturers' offices. The latter are commonly keen and interested listeners to the salesman's arguments, and are usually willing to give his products a trial. The former—the railway employes—are apt to show slight interest and often are actually antagonistic to any suggested change. This has puzzled many a salesman, and apparently it puzzles the editor of the Electric Railway Journal. We quote from a recent editorial entitled "Is It Difficult to Sell a New Idea to a Railway Manager?"

> A question put to us not long ago by a manufacturer whose business brings him into contact with a wide line of industries was this: "Are railways businesslike?" Yankee style, we asked him: "Businesslike in what sense?" His reply was: "Businesslike in the sense of studying new money-saving processes on merit." Drawing then upon his experience with other industries he continued somewhat along these lines: "Compared with manufacturing industries, railway managers do not seem to have the same acute business sense. For example, several years ago we spent many thousands of dollars to develop a certain process before we tried to commercialize it. When we brought it to the attention of people in several competitive lines of business, they 'perked up' at once. No sooner had the process been explained to them than *they* began telling *us* how many thousands of dollars they would be able to save. Their only concern was that their competitors might 'beat them to it'! When we put the same proposition before the steam and electric railroads, it was a different and sadder story. A few here and there asked to be shown and then bought, but the majority were skeptical. It's hard for me to understand the difference in viewpoint. What's the answer?"
>
> Our interlocutor had struck bottom, and we had to answer with declarative instead of interrogative sentences. We were embarrassed to make the admission, but we did say that it seemed to us that the difference was largely due to the fact that the manufacturers always had before them the costs of their operations compared with those of others who were selling to the same trade, whereas the railway company seldom had real production costs and still more seldom compared them to advantage with other properties. Furthermore, such comparison was difficult because of varying factors in different towns. Another difficulty was that the frequent change in control compared with privately owned concerns put a premium on the use of goods of lowest first cost instead of lowest continuing cost.
>
> "That's too bad," said our friend dryly, "but don't you think that the railway men would have been a bit keener, too, if they had to hustle everlastingly for customers?" And then we thought it was time to leave!

The editor of the Electric Railway Journal gives two factors as the reason why railway managers are usually less keen than manufacturing managers to adopt new ideas, namely (1) lack of adequate cost analysis, and (2) frequent changes in management. While those are factors worthy of consideration, they are not the predominant factors, in our judgment. The great sources of the trouble are (1) the failure to pay railway managers in proportion to their efficiency, and (2) the failure to have an intelligent critic who takes the place of the owner of a small company, and whose income depends mainly upon the profits of the company.

The writer has been in close, even intimate, touch for more than a dozen years, with a great many steam, electric and other public utility companies, both large and small. He has observed that while the large companies usually excel in engineering, the small individually owned companies usually excel in management. While the large companies have better load factors, buy more economically, and in other ways enjoy the economic advantages that go with large size, the small individually managed companies operate with proportionately fewer men, and have a keener eye for bettering their profits.

It should be obvious that the fact that a large electric company manufactures power at less cost per kilowatt hour than a small company is not the sole and final criterion by which to judge the relative efficiency of management. Mere size of plant units alone gives a marked economic advantage in power generation, often without any merit attaching to the management for that factor. The low unit costs of generating power with large plants itself tends to hide the poor business management which often exists in the big power companies. Similarly in railway operation, low ton-mile or car-mile costs do not of themselves prove superior management. They may only show greater density of traffic.

Until men more generally realize that the most important single law of management is to pay all employes, including managers, in proportion to their economic performance, we shall continue to have big companies showing large profits, yet poorly managed. We shall see great savings effected through the elimination of competition, followed by a decided falling off in inventions and in the use of newer devices by those in the employ of the big companies. What is true of the big companies is true—and to a more marked degree—of city, state and federal governments, and for the very same reason. A limited salary for managers and executives is the surest means of deadening ambition, killing initiative and halting progress.

## Will Motor Truck Competition Revolutionize Railway Operation?

Some of the steam and electric railway journals have awakened to the fact that motor trucks are already taking much of their short haul freight and would take a great deal more if the highways were all good, and are beginning to decry the motor truck as an economic freight carrier. Thus one railway journal recently said:

> Transportation of freight by truck at the present time is not only uneconomical but is highly unpatriotic since it takes both man and money power from more essential enterprises. The particular job of the railways in this connection must be first properly to equip and prepare themselves for the handling of this business, and second, both by deed and by suitable publicity, to show that of the two methods of handling the freight business, theirs is the more essential.

But the stark fact is that motor trucks are competing both with electric and steam railways for business and are getting it in large quantities. To do so they must either give a lower rate (including the terminal costs), or they must give enough quicker service to justify the shipper in paying a higher rate. All talk about lack of patriotism on the part of truck owners is beside the point. Here, if anywhere, "money talks," now as in times of peace.

We are not of those who believe that motor trucks will displace railways except where the traffic is light or the haul long, and it may happen that when railway managers put their wits to work motor trucks will often find it difficult to compete with railways on short hauls. But the fact is that American railway companies have always ignored the possibility of so organizing their business as to reduce the cost of delivery over the roads and streets at both ends of the rail haul. They have said: "That is the shippers' and the consumers' problem—the hauling one, the highways—and we shall not consider that part of the transportation problem."

But now the railways are beginning to learn that because they ignored both ends of transportation cost, they are losing a large part of what they thought was securely theirs for all time. It is the old story in a new binding. Let any man ignore his customer's welfare when he could help his customer, and eventually the ignoring will "cost him dear."

Wellington, in his "Economic Theory of Railway Location," lays down the rule that a railway should be located through the "center of gravity" of the products to be hauled; because, even though it may not pay at first to do so (because of high costs of right of way and terminal lands), it will pay the railway eventually by insuring against the loss of business to some other railway that will locate through the "centers of gravity" and thus reduce the total transportation costs to the customers. That was excellent and far sighted advice. But as railways have come to enjoy greater freedom from competition from other railways, they have tended more and more to ignore the costs to their customers for hauling over the roads and streets. So they are suddenly being confronted with a competitive situation that is by no means pleasing to contemplate.

Short haul railway rates will have to be lowered. Terminal facilities will have to be improved in order to expedite loading and unloading, for time of transportation is one of the big factors in favor of motor trucks. And it may even happen that railways will be forced into the trucking business themselves. Possibly we may see a great extension of the use of motor trucks that have special wheels permitting them to run on rails or pavements indifferently. Certain it is that the motor truck is going to arouse railway managers as they have not been aroused in twenty years.

## The "Voice of God" as Heard in Buffalo

The public service commission of upper New York state ordered a 6 ct. street car fare in several cities, but the Supreme Court of the state ruled that the increased fare could not be put into effect without the consent of the cities, because 5 ct. fares were specified in the street railway franchises. Accordingly the City Council of Buffalo adopted a resolution waiving the franchise restriction, but by a special referendum vote the citizens overruled the action of the council. The vote was 35,661 for the repeal of the City Council's action and only 7,044 in favor.

There has seldom occurred a better illustration of the fallacious principle involved in permitting the general public to decide an economic question involving many technicalities. Also it would be hard to find a better illustration of overwhelming public unfairness toward a public service company. Consider the significance of the fact that only one voter in six had enough sense to uphold a decision of the state public service commission even after it was endorsed by the City Council. The public knew at least one thing, and that was that prices and wages had advanced fully 50 per cent. They knew also that the employes of the street railway were on the verge of striking for increased wages. They knew that they themselves had no such acquaintance with the facts of the case as their representatives had. Yet five voters out of six paid no attention to the facts that they did know, and made no attempt to get at the facts that they did not know. It was enough for them that the street car company was asking for another cent on each fare, and that they, the voters, would have to pay it.

There is one redeeming fact in the situation at Buffalo, namely, that every newspaper but one in the city condemned the action of the voters, and that all the large banks of the city issued public statements urging the people to grant the 6 ct. fare.

"Vox populi vox dei," says the old Roman proverb, but certainly it is queer "voice of God" that we hear in the "voice of the people" of Buffalo.

## Public Service Commissions and Standardized Industry

To the Editor: Permit me to commend the first editorial utterance in your issue of Sept. 18, 1918: "Have Public Service Commissions proved to be a failure?"

I assume that we must attempt to picture what would have been the condition today had we had no Public Service Commissions, if a full analytic answer should be attempted to your question; but your article answers the question so nearly 100 per cent negatively that every well informed business man must agree with you.

The failure of Public Service Commissions to deal fairly with corporations is costing us all very, very dearly at the present time. It is not to be supposed that any perfect machinery for dealing with corporations will be discovered at an early date.

Each clause in your article states the fact contained therein so ably and forcibly that to multiply words is useless. The writer commends, however, your idea that should an able engineer be provided for in every body of commissioners, a great deal of friction would be avoided and a great deal of needed information be given.

The article in the same issue, September 18, "Lane says the Government should own standardized industries, but where are they" is also to the point, and, I am somewhat surprised, as no doubt you were, to have an utterance of that character coming from as thoughtful and able a man as Mr. Lane.

Such a course would result in stagnation and not in any incentive toward invention and improvement. Unless we are willing to become such humble nonentities as the average German citizen, no such gospel should be either preached or practiced. There can be no such thing as complete standardization.

W. F. McCLURE
State Engineer of California.

Sacramento, Cal.

## The Single Tax Theory and Government Price Regulation

To the Editor: Having listened to, read and heard of "explosions" of the Henry George Single Tax theory on a great many different occasions, all of which "explosions" have, to date, proven to be nothing more than "mis-fires," it is with great pleasure that I have read your editorial touching upon the "fallacious reasoning" of this theory.

Coming from one concerned with my own profession, a sure-enough explosion will be most interesting to about one-half million proponents in these United States, a source of endless enjoyment and profit to numerous high-brow and low-brow opponents, and of eternal edification to the "profession of the hour." Considering the extraordinary qualifications of "we" civil engineers in the arts of perception and retention, abstract procedure, logical deduction and scientific precision, there ought to be no mis-fire when a civil engineer begins to explode the Single Tax theory. Personally, I have been unable to dynamite Henry George's arguments, though not for lack of investigation and attention. I trust that you can offer a more complete exposé of the Single Tax fallacy through the columns of your periodical, because the economic problem of taxation is, as you say, "the greatest that confronts America," and if "we" civil engineers tackle the problem and do not solve it we will lose our prestige as doctors-of-dry-science and will be in the NG class as mayors or managers of municipalities.

Your brief editorial presents, to my mind, some conflicting ideas. You say that the Henry George theory of a single tax on "land" (meaning, no doubt, "land-value" as there is a different meaning between the two terms) is "based on fallacious reasoning," yet you add that "there was real merit in his suggestion that the public should share in the unearned increment in land values."

The sum and substance of "Progress and Poverty" is that the public owns that which it creates; i. e., land value, just as the individual has a clear title to all that he creates, which is everything but land and land-value, air and air-value, seas and seas-value. In other words, the individual has created no part of our worldly sphere that existed at the time when our Creator finished the job and turned it over to us to exploit. Neither can an individual create Wall st. land-values in the wilds of Wisconsin. This can be done only by a city of souls. If this is "fallacious reasoning," wherein lies the "merit"? If we allow the individual to keep that which he has not earned or created, is burglary right and proper? In view of the untold misery, crime, disease and sin that now results from our present system of taxation, can we honestly legalize the private appropriation of publicly-created land-values?

You state that "we are now witnessing a radical application of this idea in the income tax. . . ." The present inclusion of taxable incomes cannot be classed with the "unearned increment," because they are "earned" even if the recompense is outrageously high. That is, work has been performed regardless of the amount of money paid in return. If it is proper for the Government (in other words, the public) to "appropriate" the excess profits of individuals, wherein lies the fallacy, or injustice, of the public taking all the wealth of its own creation (land-value) and keeping its fingers off private fortunes?

Why should you and I, as a partnership or firm, rob "you" to pay "our" bills and at the same time allow "me" to appropriate "our" earnings for "my" private use? Where would "you" get off? This is the condition that you and I (as the public) are now imposing upon you (as the individual).

Your "serious objection to Government price regulation," as killing the incentive to efficiency, is right and timely. When the public cannot keep its fingers off private business, or private business cannot keep its fingers off public property, there is bound to be trouble, and that is all that now ails our present system of taxation. As for the "extremes of socialism" that you properly fear, our Republicans, Democrats, et al., of the political sects are now steeping us into a chaos of radical socialism unexpected by even the most ardent socialists. As regards your apprehension of "unregulated individuals," assuming that such individuals would actually constitute the menace that your statement suggests and bearing in mind that you and I would undoubtedly be included among the "unregulated," ke have jails for them. THOMAS N. ASHTON.

Fall River, Mass.

## Rail Creep

To the Editor: Referring to the article "Rail Creep" in your July 31 issue: In the opinion of the writer, the word "creep" is a misnomer. It gives the impression that it is similar to expansion, as on a bridge span or rail itself.

In the estimation of the writer where, "Jonah is in the whale" is the crude design of track taken from horse car days and mining tram; namely, space between rail ends for expansion, and the rail not anchored to the tie (sleeper). He hopes to illustrate this by observations taken in below zero weather, when snow and ice have lodged under the rail. On level track, when the engine is "churning," the rail is "jarred" ahead by the front truck, and then pulled back by the tractive effort of driving wheels. On down grade it is driven ahead by the pounding on the joints and frictional resistance of the wheels when the brakes are set. When the locomotive is struggling up hill the rails are pulled back by the backward pull of driving wheels, resulting in the joints at the bottom of the hill becoming tight and "stretched out" at the top. It will be noticed on double track crossing that they are driven in the direction of traffic by the pounding on the flangeway gaps. It seems to the writer that the bearing in the chair would become smooth from the constant pounding, which would decrease the resistance to longitudinal movement.

The so-called "creep" question is on par with its twin brother "corrugation," in which barrels of ink have been spread in "fine haired" theory, and barrels of money spent for cure, but so far very little for prevention.

Two out of hundreds of cases the writer wishes to illustrate: In former years there was used what was known as the "stub toe" switch, since substituted by "split switch" (points) which are still used, the writer believes, on mining trams. Usually the throw end had about 2-in. play or expansion at the fixed end. Very often the "fish" bolts would rattle out, and all there was to keep the rail from turning over was a few spikes at the "fixed" end, and bridle rods at the free end. When the engine was struggling with a heavy "drag" in winter with the track covered with ice, on the driving wheel touching the rail it would slam longitudinally under the engine with the same speed of the rotation of the wheel.

Also another instance: At the bottom of a heavy grade (bank) about 88 ft. per mile (1 in 66) the rails were forced "down hill," due to the frictional resistance of the wheels when brakes were set on heavy freight "drags." There was trouble with the rails buckling and a crossing was forced out of line. To overcome this difficulty the section foreman "swiped" a set of points in order to provide expansion, and applied them without orders. It is needless to say, at the top of the hill at the point where the driver would set the brakes the joints were "stretched out to the limit."

Mention has been made by a correspondent from South America that the rail travels more on one side than the other. This is undoubtedly due to mechanical reasons, such as the fastening being tighter or binding, since South America uses the "flat-footed" rail with tie (sole) plates. It is possible that there may be more plates on one side than the other, as the plate would offer less resistance to the travel of the rail than the bare tie.

New York. JOHN JERVIS.

## Loading Rails with Ditcher at Cost of 2 Cents Per Rail

By using a railroad ditcher the Crowell & Spencer Lumber Co., of Longfileaf, La., was able to load 60-lb. rails from piles onto flat cars at a cost of about 2 ct. per rail. The crew consisted of the ditcher operator, fireman, and a section crew of 3 men and foreman. Its duties were:

One man operating ditcher.

One fireman. As wood was burned, it was his duty to keep a supply of it on the ditcher.

One man to put stakes in pockets, carry water and load spikes and angle bars.

One man on car to keep rails straight and unhook tongs. Frequently entire cars were loaded without it being necessary to unhook the tongs even once. When the operator dropped the rail 1 or 2 feet the tongs usually let go themselves.

One man on the ground to hook the tongs.

One foreman, who kept the rails turned ball up.

This crew with the American ditcher loaded 2,083 rails in 3 days, the actual working time being 4½, 5½ and 6 hours. The ditcher was on its own flat car and loaded onto empties set in front and behind it. The daily cost of the rail loading, according to the American Ditcher Scoopings, was as follows:

| | |
|---|---|
| Ditcher operator | $ 5.00 |
| Ditcher fireman | 2.50 |
| 3 laborers at $2.50 each | 7.50 |
| Gang foreman | 3.25 |
| Fuel (wood) | 1.00 |
| Oil, waste, etc. | .50 |
| Total | $19.75 |

# Comparative Costs and Results of Hand and Machine Tamping of Ties

The New York Central R. R. began experimenting with mechanical tie tampers in 1913. At the present time the company is employing the two and four tie pneumatic tamper outfits, the two tamper electric outfit with electric generator set, the two tamper electric with resistance set and two tamper electric with compound motor set. Interesting data on the use of these outfits were given by Mr. G. W. Vaughan, Engineer Maintenance of Way, New York Central R. R., in a paper presented before the New York Railroad Club. An abstract of the paper follows:

**General Results with Pneumatic Tie Tampers.** The tampers are handled by ordinary laborers, who hold them in a vertical position with the broad face of bar against the tie until the end of bar reaches the bottom of the tie, then, by swinging them back to the proper angle, the ballast is driven under the center of the tie.

In its work the tool tamps the ballast under the tie, in about the same manner only more thoroughly than the tamping picks. The pneumatic tamper, however, can be used more advantageously in many ways, especially around slip switches, and in tunnel work where a small number of men with tampers will do the work under traffic where formerly large gangs were employed and traffic discontinued while work was being done. In one particular case, 6 men did the work of 30 men.

The pneumatic tampers do better and more thorough work than can be done with picks or bars in the hands of the average track laborer. The track laborers prefer these tools to tamping picks or bars on account of the ease in handling and because they can tamp the ties without bending their backs.

There is no difficulty in holding the tool to tamp directly under the rail, in and about turnouts, frogs and other cramped quarters, or at water pans where track is more or less flooded with water. The operation of the pneumatic tampers is more efficient here than any hand tamping tools.

Owing to the shortage of labor during the year past, the force on a 4-track railroad with sections of 11 equivalent miles have consisted of a foreman, two men and a tamping outfit. By leaving the outfit out on the line and by using a work train crew to shift it each morning or night, the foreman was able to tamp every tie in his two fast express tracks in addition to installing ties and taking care of other work ordinarily done by a gang of 10 men.

Ties can be dug out and other ties can be spotted in and thoroughly tamped without disturbing adjacent ties, thus expediting tie renewals and resurfacing of the track. By equipping it with a rose drill, it can be used for drilling holes in rock excavations.

Track surfaced by pneumatic tie tampers is more even in surface and stands up longer under traffic than when tamped by hand. As an illustration, 2 miles of track on a good subgrade on the New York Central was tamped by machine and was not resurfaced for two years, there not being a soft spot that needed it.

Another section of 6 miles in length (9 equivalent miles) on account of bad bottom, was very difficult to keep in good condition. For the last two years this section has been kept in good condition with a force consisting of a foreman, four men and a tamping machine. This could not have been done without the machine except by a larger gang. All foremen who have used machines, agree that, when they have a machine with a small gang of men, they can get work done that it would be impossible to do with a small gang without the machine.

Beside the advantages mentioned above there is an immediate economy in the use of the machine, because the work can be done more cheaply. During 1917, observations were taken on three main line sections, on each of which the New York Central R. R. had a foreman and four men, with a 2-tool pneumatic tamping outfit and giving the track a surfacing lift of from 1 in. to 1½ in. Each gang surfaced an average of 10 rails a day, while it was found that a same size gang, without a machine, and under the same conditions surfaced only five rails per day. In other words the gang with the machine surfaced a mile in 16 days and without a machine in 32 days. Ordinarily with laborers' wages at 22 ct. per hour it will cost from [illegible] to [illegible] ct. each to tamp a tie with a tamping pick.

**Comparative Cost of Tie Tamping by Hand and by Pneumatic Outfit.** A competitive test conducted on one of the large railroads. Hand vs. Machine tamping using a four tamper gasoline outfit, was as follows:

| | Number of men | Time, hours | Feet of track tamped |
|---|---|---|---|
| Hand gang | 16 | [illegible] | [illegible] |
| Foreman. | | | |
| Machine gang | [illegible] | [illegible] | [illegible] |
| Foreman. | | | |
| Saving | 10 | [illegible] | [illegible] |

| | Number of men | Wages | [illegible] | Total |
|---|---|---|---|---|
| Hand gang | 16 | $43.50 | | $43.50 |
| Foreman. | | | | |
| Machine gang | 6 | $18.50 | $6.95 | $25.45 |
| Foreman. | | | | |
| Saving | 10 | | | $18.05 |

Saving in Favor of Machine Tamping.

In tamping [illegible] [illegible]

On the San Francisco-Oakland Terminal Ry., the first cost was a prime consideration, owing to the widespread need of retrenchment, and the cost of the compressor was saved by using a battery of six 11-ft. capacity pumps on a truck. These tampers proved particularly successful in tamping heavy special work. On this railroad they allowed 6 men with the machines for work which formerly required 16. Of the 6 men one is stationed to flag vehicles, while another handles the connection to the trolley wire, leaving the remaining four to do the tamping.

With labor at $2.50 per day, the relative costs are: Air tamping $15, hand tamping $40, a saving of $25 per day. As a matter of fact the tie tampers paid for themselves within 10 days. The tampers are also used for flat tamping in advance of concreting, fitted with chisels when wanted for chipping concrete and with cutters when used in stripping out asphalt

A test made on the New York Central R. R. to determine the cost and rate of work was as follows:

DAILY COST WITH MACHINE.

| | |
|---|---|
| 1 foreman, 10 hours at 32 ct. | $ 3.20 |
| 4 men, 10 hours—40 hours at 22 ct. | 8.80 |
| 12 gal. of gasoline at 24 ct. | 2.88 |
| Oil, 2 pints at 6 ct. | .12 |
| Total | $15.00 |

DAILY COST WITHOUT MACHINE.

| | |
|---|---|
| 1 foreman, 10 hours at 32 ct. | $ 3.20 |
| 4 men, 10 hours—40 hours at 22 ct. | 8.80 |
| Total | $12.00 |

COST PER MILE OF TRACK.

| | |
|---|---|
| Without machine 32 days at $12 | $384.00 |
| With machine 16 days at $15.00 | 240.00 |
| Difference in favor of machine | $144.00 |

When the New York Central R. R. began the use of tampers the fiscal charges were assumed as follows:

| | |
|---|---|
| Depreciation at | 10% |
| Interest at | 5% |
| Repairs at | 5% |
| Total fixed charges | 20% |

The experience for several years indicate that the depreciation and repairs are much less than that assumed. However, it continues for the present to use the above figures. It has been found that under normal conditions each machine will be used for tamping 20,000 ties per season. On this basis the fixed charges amounts to $.02 per tie, or $64 per mile surfaced. Therefore, allowing for fixed charges in the above statement, there will be a saving in favor of the machine of $80 per mile.

The New York Central machines, under adverse conditions, have been used for surfacing from 3 to 6 miles per season and, normally, should average at least 6 miles. Hence the annual saving per machine is quite substantial. This does not take into account the secondary saving due to the greater stability of the track.

**Electric Tie Tampers.**—Electric tie tampers were first used on the New York Central in 1913. These have been improved until the present type of machine has been developed. The tampers now used weigh 90 lb. complete, the tamper weighs 86 lb., and the bar 4 lb. The motor is contained in a bell on the side of the machine and drives a crank in the back of the casing. The crank in turn moves a reciprocating cylinder within which is a free piston driven back and forth by the air compression in the cylinder and a solenoid at the lower end of the tamper, the reciprocating cylinder shifting the magnetic field produced by the solenoid. Suitable handles are provided to support the tool at its center of mass and a specially designed nose piece holds the tamping bar in place. The control is located in a switch mounted in the upper handles. On account of the weight it requires two men to operate each machine.

Twelve of these machines are now being used in the electric zone, and others are in service on the exterior zone. In the electric zone current is taken from the third rail and is conveyed to the machine through resistance boxes by means of a contact device which is laid across the rails. The resistance used is similar to that in the heaters installed in electric cars. The resistance unit is 10½ in. high, 12 in. wide and 42½ in. long. In the exterior zone the power is secured from a generator set mounted on a hand car which weighs complete 2,150 lbs. The equipment consists of a car and 4-HP. gasoline engine connected to a 220-volt generator and equipped with a clutch, so that the engine may be used to drive the car. The outfit supplies ample power to operate two tampers with a surplus for lights and drills.

As a further development, it has been planned to use the tampers in the electric zone between Utica and Syracuse. In this district, because of the varying voltage, it is not possible to use the resistance as in the electric zone. Instead, it is proposed to use a motor generator set in which both the motor and generator set are compound-wound. This motor generator set is so designed as to take care of the fluctuation in the voltage and, as the weight is only 240 lb., it can be easily handled by three men.

The generator set is enclosed in a strongly constructed box and moved to points where required. A third rail contact device has been designed which need not be removed for traffic. The cost of current for operation is 7 ct. per hour on the basis of 3 ct. per K. W. plus 10 per cent for accounting.

In tamping track, the machines are generally operated in sets of three, so that in case of accident, an extra tamper is at hand with which to continue the work. The tamping is done by two machines working simultaneously on opposite sides of the tie. With them it is possible to tamp ties closer together than would be possible to tamp by hand, all the space necessary being that into which the tamping bar can be driven. They are especially useful around switches where the ties are closely spaced. Some interesting data has been compiled showing the cost of work with the machines as contrasted with hand.

**Cost of Tie Tamping with Electric Outfits.**—A test was made with a set of electric tampers late in the winter under unfavorable working conditions. They were operated in this case, from an engine generator set mounted on a car. The outfit was assigned to a regular main line section gang consisting of one foreman and five men. Two men were assigned to each machine, which is necessary on account of the weight. Four men were doing the tamping and the fifth digging out and feeding ballast to the machine, dressing up track, etc. The work consisted in making the final surface after the track had been raised 12 in. previously but had not yet been put in service, the ties being tamped 16 in. on the outside of the rail and 8 in. on the inside. Under these conditions an average of 27 ties were tamped per hour. The daily cost of the work was:

| | | |
|---|---|---|
| 1 foreman, 8 hours at 32 ct. | $ 2.56 | |
| 5 men, 8 hours—40 hours at 22 ct. | 8.80 | |
| Gasolene, 4 gal. at 24 ct. | .96 | |
| Engine oil, ⅔ pint at 6 ct. | .04 | |
| Total per day | $12.36 | $12.36 |
| Time of crew going to and from work | | 1.42 |
| Total cost | | $13.78 |
| Ties tamped | | 216 |
| Cost per tie | | $0.064 |

Another test of tamping by hand under similar conditions shows, with the above, the comparative cost of tamping by hand and by machines. Tamping by hand, one foreman and six men at a cost of $14.76 per day, tamped one mile of track in 26 days, or a total cost per mile of $383.76. The gang with the electric outfit tamped a mile in 15 days, which at $13.78 per day makes a total of $206.70 per mile, showing a difference in favor of the machine of $177.06 per mile.

The cost of tamping with electric tampers per foot of track, including fixed charges, figures up as shown below. The fixed charges are calculated on the basis of the actual costs of one engine generator set mounted on a car; two electric tampers; two resistances; including contacts, cables, etc., which are used when current is taken from the third rail instead of the engine generator set. The fixed charges per day are based on the assumption that the machine will be in service 180 working days per year:

TIE TAMPERS OPERATED FROM A GENERATOR.

| | |
|---|---|
| Operation— | |
| Foreman, 10 hours at 32 ct. | $ 3.20 |
| 5 men, 10 hours each—50 hours at 22 ct. | 11.00 |
| Gasolene, 4 gal. at 24 ct. | .96 |
| Engine oil, ⅔ pint at 6 ct. | .04 |
| Fixed Charges— | |
| Depreciation—generator at 15% | .42 |
| Depreciation—two tampers at 30% | .67 |
| Interest and maintenance—generator at 10% | .28 |
| Interest and maintenance—2 tampers at 15% | .33 |
| Total per day | $16.90 |
| Average of 356 ft. tamped per day | |
| Total cost per ft. | $0.047 |

TIE TAMPERS OPERATED FROM THIRD RAIL.

| | |
|---|---|
| Operation— | |
| 1 foreman, 10 hours at 32 ct. | $ 3.20 |
| 6 men, 10 hours—60 hours at 22 ct. | 13.20 |
| Power, 96 K. W. hr. at 1 ct. | .96 |
| Fixed Charges— | |
| Depreciation—2 tampers at 30% | .67 |
| Depreciation—2 resistances at 15% | .08 |
| Interest and maintenance—2 tampers at 15% | .33 |
| Interest and maintenance—2 resistances at 10% | .06 |
| Total per day | $18.50 |
| Average of 356 ft. tamped per day | |
| Total cost per ft. | $0.052 |

In above test the tampers were in actual service an average of eight hours out of a 10-hour day. Where the tampers are operated from the third rail six men in the gang are necessary, as a watchman is employed who does not do anything except to look out for trains.

## Rules for Foremen

The following rules are reprinted from the Efficiency Magazine:

Be Fair. Have no favorites and no scapegoats. A foreman has to act as judge many times every day; therefore, he must be just.

Make Few Promises and Keep Them. A foreman must be the exact opposite of a politician. Politics is the art of making promises; and sometimes a foreman forgets that his job requires a far higher standard of truth and honor than prevails in politics.

Don't Waste Anger, Use It. Your anger is the most valuable thing you have; but you should not use it carelessly. Keep your most forceful language for special occasions. Before a foreman can control other people successfully he must learn to control himself.

Always Hear the Other Side. Never blame a worker until he has been given a chance to give his point of view.

Don't Hold Spite—Forgive. When you have had to scold a worker, be sure that you go to him the next day in a friendly way and show him how to do something. There should always be blue sky and sunshine after a storm.

Never Show Discouragement. Never let yourself be beaten. A foreman must have perseverance, and "never say die."

Notice Good Work as Well as Bad. Mingle praise and blame. Let the workers see that you can appreciate as well as condemn.

Watch for Aptitudes. Take a keen human interest in your workers. Notice them. Study them. Put each one where he can do best.

Be an Optimist. Don't let your worries and troubles deform you into a pessimist. Inspire confidence. Put the "righto" spirit into the works. Say, "Come along, men, all together."

Take Your Full Share of the Blame. This is the most difficult of all. It is heroic, but the foreman who can share both blame and praise with his workers will have discovered the secret of managing men.

# Concrete Caissons of Trapezoidal Section in Breakwater Construction

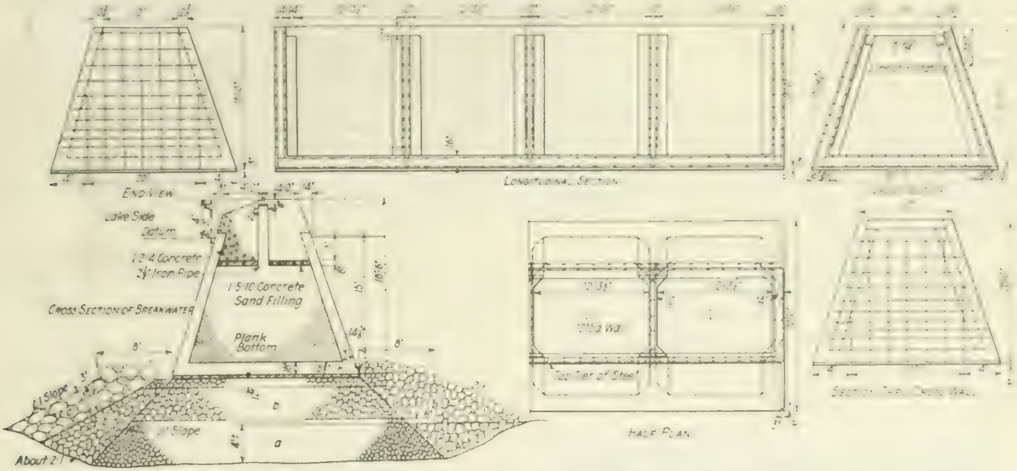
Concrete caissons of trapezoidal section are being used for the construction of the south breakwater at Racine, Wis. Previously concrete caissons of rectangular section have been used for the north breakwater at Racine and also at Milwaukee, Sheboygan, Manitowoc and Algoma harbors on the west shore of Lake Michigan. The trapezoidal section was adopted primarily to effect greater economy in breakwater construction along with increased stability. The principal saving is due to the reduced section of superstructure compared to that of the rectangular type, the total resultant saving amounting to $25 or more per linear foot of breakwater. Three heights of caissons are being used in the south breakwater at Racine: 21 ft. 3 in., 18 ft. 3 in., and 15 ft. 3 in. All caissons are 54 ft. long, 10 ft. wide on top and have side walls sloping 1:3. The smaller sizes are formed by cutting 3 ft. in height from the bottom of the form for the next larger size. The bottom widths are 24 ft., 22 ft. and 20 ft., respectively. Each caisson has 3 cross walls 10 in. thick. For the largest size caisson the side walls are 12 in. thick at the top and 16 in. at the bottom; end walls are 16 in. thick and the bottom 24 in. Sides, ends and cross walls are provided with double reinforcement, and a mixture of 1:2:4 concrete is used, the coarse aggregate being 1 in. broken stone.

The caissons are built at Milwaukee, Wis., by hired labor with a Government plant constructed especially for the purpose. The plant is equipped with locomotive crane, a 1-cu. yd. mixer with side loader, sand and stone bins for gravity charging and sheds for steel and cement. The crane is used for handling forms, setting steel, and hoisting concrete.

The bottom of the form is a 3-in. plank placed on blocking. The plank remains as a part of the caisson, being anchored to the concrete with ⅜-in. x 7-in. wire spikes. The core forms are supported on steel knees which rest on the plank bottom. The ends of the core forms are in halves so that by unbolting the center joint they can be taken apart for removal. The bottom reinforcing steel is suspended in position from the cores and by small concrete briquettes laid on the plank bottom. The reinforcing steel for sides, ends and cross walls is assembled into mats over templates on the wharf, is hoisted to place by the crane, and is secured in position with steel spreaders and wire. The outside forms are held by 12-in. x 18-in. trussed timber strongbacks with tie rods passing just above the top and below the bottom of the caisson. The entire [illegible] of concreting, which is done in one continuous operation.

Caissons are allowed to harden 10 days and are then launched over ways having a slope of 1 ft. vertical to 8 ft. horizontal. The ways extend from a height of about 3 ft. above water to a depth of about 20 ft. below the surface, so that the largest caisson floats free of the shoes without plunging. Elimination of plunging permits the minimum amount of reinforcement to be used and makes it unnecessary to place temporary decks for launching. Two launch ways are provided at the Milwaukee plant which makes it possible to build and launch a caisson every 6 to 9 days, depending on the size. The launching weight of the largest size caisson is a little over 500 tons.

After launching, the caissons are generally sunk on the lake bottom near the plant in such depth of water that the top will remain above the surface. When delivery is to be made, they are syphoned out, provided with temporary deck and towing rig and towed to Racine where they are transferred to the contractor for the breakwater work.



Plan and Sections of 54 ft. by 20 ft. 10 in. x 15 ft. 3 in. Reinforced Concrete Caisson for South Breakwater, Racine, Wis.

The decks are 3 in. in thickness, consisting of 2-in. T. & G. plank and 1-in. matched lumber between which is a layer of painted canvas. Each deck consists of four sections which are secured in place by anchor bolts embedded in the top of side and end walls of the caisson when moulded. The decks are drawn down on a ½-in. water hose placed on top of the caisson walls to secure watertightness and the joints between sections are calked. The towing speed is 2½ to 3 miles per hour with two caissons per trip. Decks are removed by the contractor at Racine and returned to Milwaukee on a small scow taken with each tow for that purpose.

The breakwater is being built on a stone foundation with trench. A trench with a bottom width of about 40 ft. and a depth of 4 ft. below the natural sand bottom of the lake is dug and then filled to a depth of 4 ft. with flux stone from dump scows. The remaining height of the foundation is made of 50 to 200-lb. stone, except that a thickness of about 1 ft. at the top consists of stone weighing from 10 to 50 lb. each so that leveling can be done as easily as possible. The leveling is done by divers so as to provide a uniform bearing over the entire bottom area of the caisson. A small amount of 500-lb. to 1-ton stone is placed on the lake side of the foundation to prevent wave action from disturbing the smaller stone.

Caissons are floated to place and sunk onto the stone foundation by filling them with water, either through siphons or by pumps. Stone weighing 50 to [illegible] lb. and also sand is used to fill the caissons to within 4 ft. of the top. The sand or stone filling is sealed over with 6 in. of meager concrete placed in the dry, to prevent loss overboard by wave action before the superstructure is built.

The concrete superstructure, which is made of 1:2:4 concrete, using 2½-in. broken stone, extends from the meager concrete to a height of 3½ ft. above the top of the caisson. Timber forms are used for molding the upper 3½ ft. and concrete is deposited in the dry. The top of the completed structure is 4 ft. above U. S. datum for Lake Michigan or about 5 ft. above mean lake level.

Where sand filling is used, a well 12 in. square is provided, which extends from the sand filling up through the superstructure to within 6 in. of its top. A 2½-in. pipe with cap extends from the top of the well to the top of the superstructure. The well and pipe will permit soundings to be taken from time to time in each pocket of the caisson to determine whether or not there has been loss of sand through cracks in the caisson walls, which might possibly develop on account of uneven settlement on the foundation or from other causes. In case of serious loss of sand filling, it is proposed to fill the void with grout placed through the pipe and well.

The total length of concrete caisson breakwater to be built it 1,512 ft. of which 702 ft. remain to be completed this season. The work of building the foundation, sinking and filling caissons and molding concrete superstructure is being done by Greiling Bros. Co. of Green Bay, Wis. Robert Moser is their local superintendent of construction. The work is being done under the direction of J. A. B. Tompkins, District Engineer for the U. S. Engineer Department. E. M. Nisen is U. S. Assistant Engineer and A. I. Reed is U. S. Inspecting Engineer.

## Railway Ditching With Teams and Scrapers And With Steam Ditchers

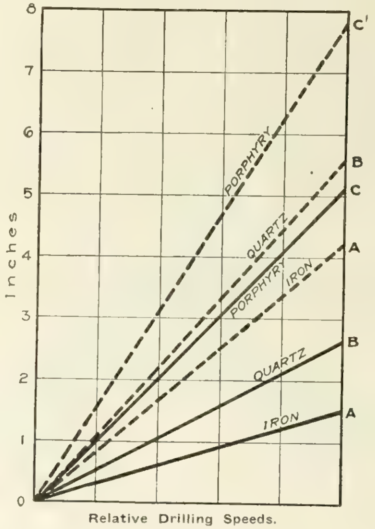
In a committee report submitted at the recent convention of the Roadmasters and Maintenance of Way Association it is stated that teams and scrapers have given good results in railway ditching. Dirt can be handled in this way in very short cuts and across track for 20 to 25 ct. per cu. yd. These figures are based on teams at 80 ct. per hour and labor at 25 ct. Where heavy ditching is to be done the committee recommends the use of steam ditchers, together with at least two 16 to 20 yd. side dump cars and a spreader car for short hauls. For a longer haul from four to six side dump cars should be used. A light engine can be assigned to this work. With an outfit of this kind, which includes a train crew, ditcher engineer and firemen, dirt can be handled for 10 to 25 ct. per yard, depending on the haul.

**Attendance at German Technical Schools.**—The number of students at technical schools of Germany is 70 per cent less than in pre-war times, according to a U. S. Consular Report, which bases its information on an article in Aug. 27 Frankfurter Zeitung. In the eighth war semester—the summer of 1918—states the report, the 11 high technical schools of the Empire had 2,231 students on the rolls, as compared with 1,721 in 1917, and about 12,000 at the outbreak of the war. The increase over 1917 is due chiefly to the return of students from the field, some of whom were furloughed to finish their studies, while others were invalided home. The school registers carry 10,145 names of students "on leave." Among the students in attendance were 183 women, most of whom are studying architecture or chemistry. The schools had, in addition, 916 men and 1246 women registered as "guests" (hospitants), so that the total number of persons in attendance was 4393, as against 13,000 to 14,000 in peace time. The school at Aix-la-Chapelle showed the greatest increase in the number of students, owing to a larger attendance of students from Luxemburg. Charlottenburg had 429 students in attendance, holding thus the first place, as it did in peace times. Then followed Munich, with 410 students; Dresden had 273; Aix-la-Chapelle, 253; Darmstadt, 174; Karlsruhe, 162; Hanover, 152; Danzig, 123; Stuttgart, 114; Brunswick, 75; Breslau, 66.

## Proper Forming and Treating of Bits Increase Drilling Efficiency

That increased efficiency in drilling can be obtained by proper forming and treating drill bits is pointed out by Mr. Howard T. Walsh in an article in Mine and Quarry. The accompanying curves, reprinted from his article, show results that were obtained by one of the largest copper mines in this country. Lines OA, OB, OC show drilling speed in inches per minute obtained with their standard machine-sharpened drill bits using ⅛-in. changes in gage. Lines OA′, OB′, OC′ show results obtained by using bits with proper reaming edges and faces and a 1/16-in. change in gage. In addition to increased drilling speed, their steel breakage has decreased from 10.5 per cent to 1.5 per cent and the amount of footage obtained from each steel before resharpening was increased 50 per cent.

Mr. Walsh states that a number of vertical gaging dies, furnished with the Sullivan sharpeners, may be used in forming bits with correct reaming edges and faces. These dies are equipped with a positive gaging device arranged for 1/16-in. changes in gage. If any mine official will go into this situation carefully, he may expect approximately the following results: Increased drilling speed from 40 to 100 per cent; decreased steel breakage; increased footage from each steel sharpened; lower sharpening costs; less time lost underground; and life of drilling machines increased.



In using the gaging dies, the bit is upset in the clamping die by the horizontal hammer and dolly in the usual manner. The vertical dies are adjusted to the proper gage by means of the key and thumbscrew. The proper gage, reaming edge and wing taper are applied by hammer action under the vertical swaging hammer. Changes in gage for the different steels in a set are made in a few seconds.

The popular "bull" bit, the familiar "cross" bit or the new "double arc" bit can be made in these dies rapidly and cheaply. The all-hammer process and the alternation between the dolly and vertical swages compact the metal and improve its wearing quality.

**Street Car Fares Increased in 240 Cities.**—Up to Aug. 1, street car fares have been increased in 240 cities in the United States. These cities have a population of 12,000,000. The amount of increase ranges from a straight 10 ct. fare to the abolition of workmen's rates. Three cities, one which is Tacoma with municipal lines, have a 10 ct. fare. One city has an 8 ct. fare, and 43 cities have a 7 ct. fare. Boston is the largest city in which this latter rate is charged.

# Labor Saving Appliances for Rail Renewing

Three types of specially devised machines are being used in rail renewal work with excellent success by the Maintenance of Way Department of the Chicago, Burlington & Quincy R. R. These machines were described in a recent issue of the Railway Review, to which we are indebted for the illustrations and information that follow.

**Rail Handling Machine.** This machine, Fig. 1, picks up rails which have been distributed along the track, and lifts them into position for laying in the track. Four men are required to operate and perform the work expeditiously; namely, one operator to handle and take care of the machine; two men to steady the ends of the rail which is being picked up, and one man at the center to apply the rail tongs. This machine can pick up 100-lb. rails up to 39 ft. in length and place them in position at the rate of 90 rails per hour, if necessary.

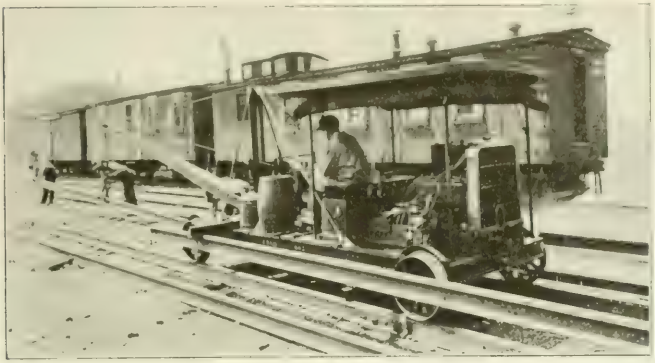


Fig. 1—Rail Laying Machine.

Power is furnished by a 4¼x5½, four-cylinder gasoline motor and so connected that the operator can move the machine in either direction, at a speed varying from 4 to 16 miles per hour. The low speed is used while laying rails, and the high speed only when going to and from stations. All levers for operating the hoist and machine in general are conveniently located near, and manipulated from the operator's seat.

The weight of machine complete is approximately 4500 lb., and it is so constructed that four men can remove it from track in less than six minutes, using a pair of specially designed trucks or dollies, which are placed underneath the frame, allowing the machine to be run upon two crossing planks laid at right angles with the rails.

Suitable trailer cars can be coupled to this machine, whereby a gang of 75 to 100 men is quickly conveyed to and from the work, thereby eliminating the necessity for hand or motor cars.

In addition to laying steel the machine is used to haul and distribute extra rails, spikes, bolts, etc., when the steel gang is closing or finishing the track. It is also successfully used as a rail loader, in which case it is placed and anchored on a flat car, and while the train is in slow motion the old rails are picked up and placed in another car ahead.

Recently, one of these machines was in operation near a station where the rail was distributed on either side of the track and several switches which were to be placed were piled along a team track. With this machine four men distributed the rail, frogs and switches in two hours. It would have taken 15 men six hours to do this work by hand.

During a four-hour run a gang of 58 men, using one of these rail-laying machines, laid 240 90-lb. rails in four hours. On another day a gang of 48 men, using one of these machines, laid 157 100-lb. rails in 145 minutes, the machine being delayed several times waiting for adzers. During a part of this run, 60 rails were laid in 45 minutes.

From the standpoint of labor saved when laying rails by hand, 16 men are required on tongs; while with the machine only three men, in addition to the engineer, are required for the same work, effecting a saving of 12 men.

**Machine for Sawing or Marking Ties.** The purpose of this machine (Fig. 2) is to saw or mark ties which require adzing. Circular saws mark the ties on each side of the rails, being set and gaged from the top of the rail to cut at a depth corresponding to the bottom of the rail. It is readily understood that by sawing the ties in this manner, very little intelligence and effort is required to do an accurate job of adzing, not only simplifying the task, but also giving the required even and uniform bearing for the tie plates.

The machine weighs approximately 2800 lbs., and is provided with a certain pivot, permanently attached underneath the car frame. After raising one end of the car, a wooden block is placed under the pivot and the pack is removed, after which the machine is swung at right angles to the track and pushed upon two planks properly placed on the right-of-way. This operation is so simple that two men can take the machine off the track in less than six minutes.

Power is furnished by a 4½x5½, four-cylinder gasoline motor, which propels the machine at 3 to 18 miles per hour, in either direction. The low speed is used while sawing ties and is connected synchronously, so that when the sawing is extra deep, the machine slows up in accordance with the speed of the engine.

Two men are required to successfully operate this machine: one operator to handle machine and look after the work in general, and one assistant to walk ahead looking out for obstructions such as rock, rail braces, etc. Under normal conditions 3 to 5 miles of track are sawed per day, depending largely on the number of trains during the working hours.

**Rail Drilling Machine.**—Another appliance that has been found particularly useful in rail renewing is a rail drilling machine, the function of which is to drill holes in the rails for rail anchors, connections, etc., superseding the hand power drilling machines. It is illustrated in Fig. 3.

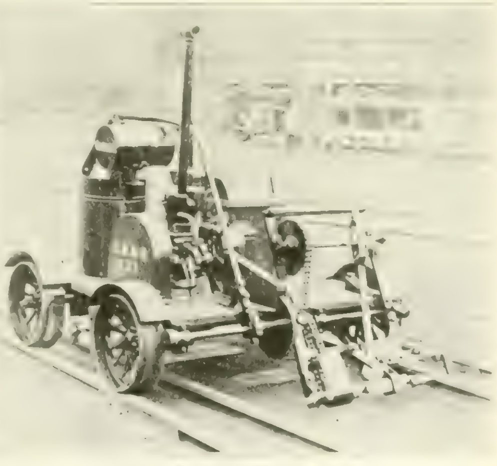


Fig. 3—Rail Drilling Machine.

Power is furnished by a 4-h.p., 4x4 single cylinder, 4-cycle, water-colled gasoline motor, which propels the car at a speed of 18 miles per hour while going to and from work. The drill frame is so constructed that it can be swung in position and operated with one hand, drilling any size hole up to 1 [illegible] in. The time required to move, set machines, and drill the hole is less than one minute.

Under normal and average conditions it requires two men to successfully operate this machine at its maximum efficiency; namely, one operator to handle the machine and one assistant to mark the location of holes and to aid in removing the machine from the track, etc.; and on main line, necessary flagmen for protection. In cases where the work warrants, two of these machines are operated close together, using only one experienced operator and two assistants, and only two flagmen.

The average number of holes drilled with one of these machines per day is 240, requiring 3 gal. of gasoline and 2 pints of lubricating oil. The drill bits are lubricated or cooled with pure water contained in a tank at the rear of machine and conveyed to the drills by pipe and flexible tubing. The weight of this machine complete is 1140 lb. and two men can remove same from the track in less than 4 minutes.

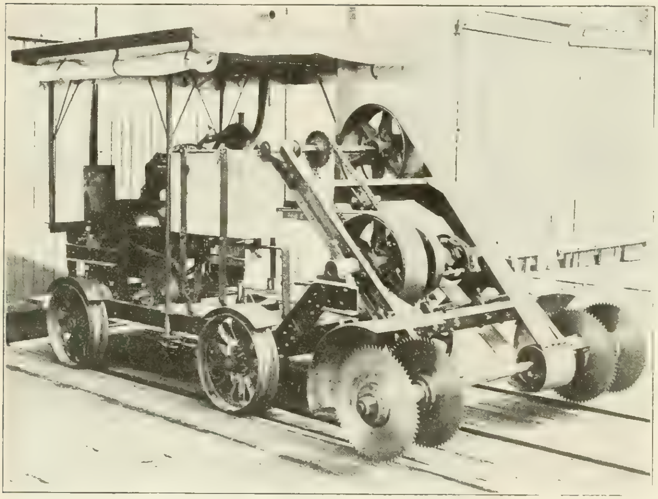


Fig. 2—Machine for Sawing or Marking Ties.

In addition to several prominent features, such as automatic feed, etc., a drill grinder is also mounted on the frames of this machine, and the drills are ground while waiting for passing trains.

The machines were devised by Mr. W. T. Krausch, engineer of buildings, and Mr. E. F. Weber, assistant engineer C. B. & Q. R. R.

**Engineers Wanted for Construction Division of Army.**—The U. S. Civil Service Commission will hold open competitive examinations for the following positions: Chief of survey party, $2700-$3000; transit man, $2400; levelman, $2100; rodman, $1800; chairman, $1800; one topographic draftsman, $2100. The last position is open to women. It is expected that the following appointment will be made from these examinations: 50 chiefs of survey party, 50 transitmen, 25 levelmen, 125 rodmen, 150 chainmen, for duty in the field; and 50 draftsmen for duty in the field and in Washington, D. C. Competitors will not be required to report for examination at any place but will be rated upon the sworn statements in their applications and upon corroborative evidence adduced by the Commission. The duties of chief of survey party will be to take charge of and supervise survey parties engaged on field surveys in connection with the layout of camps, sewer systems, railroad yards, docks, wharves, etc. Application blanks (Form 1312) can be obtained from the U. S. Civil Service Commission, Washington, D. C., or from the U. S. Civil Service Boards in the larger cities.

# The U. S. Employment Service And Railway Labor*

The United States Employment Service has undertaken the task of recruiting man power for the most essential service. The railroad division has been organized for the recruiting of all classes of railroad labor. It is in a class by itself. Unfortunately, we were slow in starting. The wage was low and when the first call was made for common labor at a higher wage by the Government it drew more heavily from the railroads than from non-essential industries. A great effort is being made to correct this evil. The railroad wage has been increased to compare more favorably with the increased cost of living. The long haul or transporting of labor from one part of the country to another is being discouraged. The recruiting of labor at so much per head is being abolished. Fee agencies, a most distasteful practice, must no longer exist.

At present we are looking to the Mexican for relief, more especially in the Southwest, but Mexicans are always such an unknown quantity and so undependable. Congressional assistance has been granted, but men have been held back on the other side of the border by the political trickster for pecuniary advancement. By co-operation with the United States Employment Service and the United States Immigration Service it is hoped to straighten out the tangle and get more men. Should the situation be cleared, the southwest territory can be supplied during the winter months and in the spring we can ship to northern roads.

The United States Employment Service is destined to become a great branch of the American government. It has come to stay. Established for the protection of both capital and labor, it is designed to prevent unrest and strikes, to compel arbitration by the appointment of boards, to adjust all differences while business continues without interruption and to avoid the enormous losses experienced in the past.

A clearance section has also been established. This department or branch of service makes a complete tabulation of all labor recruited in each state, and these reports go to the general clearance division at Washington. In this way it is possible to ascertain how much labor is furnished by each state. Each state has been given its quota; an estimated number based upon its population and its former record, and as this record has been incomplete no doubt these figures or percentages will have to be adjusted from time to time.

Chicago has been drained to such an extent that it is absolutely impossible to ship as many men to other states as have been shipped in the past, unless many non-essential industries are closed. This part of the service will be looked after by the war industry and community boards, which have already been established. It is their duty to decide what are essential and what are non-essential.

The Employment Service was organized only the early part of this year as a branch of the Department of Labor, it started with a comparatively small appropriation, but it already has established some 600 distinct recruiting offices. Our records show that we are recruiting about 12,000 men per month in Chicago for the railroads alone and we need twice that number.

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*From an address by M. G. Kibbe of the Railways Division, of U. S. Employment Service, presented at the recent convention of the Roadmasters and Maintenance of Way Association.

**Contracts for New Orleans Canal.**—A $600,000 contract for locks, gates and fixed parts for canal of Port of New Orleans has been let to McClintic-Marshall Co.

# Precautions for Handling Explosives*

By ARTHUR LA MOTTE.

Manager, Technical Division, E. I. duPont de Nemours Co.

**Danger from Immediate Reloading of Bore Holes.** Don't explode a charge to chamber a bore hole and then immediately reload it, as the bore hole will be hot and the second charge may explode prematurely. Considerable heat is generated, not only by the explosive itself, but in the compression that occurs, and unless ample time is allowed between "springing" shots, accidents are likely to occur from an explosion of the charges which may be placed in the hot pocket, or become ignited from fragments of fuse or wire insulation. Of course, when the pocket is full of water and fills up immediately after each "springing" operation there is no danger from the hole being too hot, but another hazard presents itself in the loading of "sprung" holes. That is the danger of the dynamite, especially when a straight dynamite is used and the cartridges are slit, getting between the cracks and crevices of the rock in such a way that when the hole is being tamped it may be pinched under considerable pressure and cause an explosion. For this reason, dynamite of the gelatin type is much safer to use where this operation is regularly performed, but where gelatin cannot be used the next best thing is not to slit the cartridges.

**Tamping Should Be Done with Wooden Tampers.**—Don't do tamping with iron or steel bars or tools. Use only a wooden tamping stick with no metal parts." There is great danger in punching dynamite with an iron tamping rod, especially in holes bored in hard rock. It would seem a simple thing to provide miners with wooden tamping sticks and compel their use, but a number of them look upon it as a needless refinement, and always having their drill steels with them, they prefer to use them. When black blasting powder was used to a greater extent than it is now, copper was looked upon as a safe material to use with it, because it would not strike a spark, and that same feeling has descended to dynamite, but it is just as easy to detonate a drop of nitroglycerin or a pinch of dynamite with a copper hammer as it is with a steel one.

**Forcing Cartridges Prolific Source of Accidents.**—Don't force a cartridge of explosives into a bore hole. This is one of the prolific sources of accidents in the use of explosives and one of the most difficult to control. If a miner or blaster has a cartridge of dynamite sticking half way down in a bore hole, it is a great temptation to drive it further by main strength rather than let it go and waste the bore hole and all the labor that it represents. Fortunately, modern explosives, which are much less likely to explode from rough handling than the straight dynamites of 10 or 20 years ago, have reduced the number of accidents from this cause to a considerable extent. The remedy, of course, is to have the drill bits always made to gage, allowing for a sufficient clearance over the diameter of the dynamite that is being used.

**Precautions for Electric Firing.**—"Don't have a wire carrying electric current near detonators or charged bore holes at any time except for the purpose of firing the blasts." One of the dangers of having electric mining or quarrying machinery around explosive operations is the chance of one of the terminals coming in contact with the electric blasting-cap wires. Considering the care necessary to make connections properly for firing the blast purposely, it would seem that this danger is remote, but a number of accidents have occurred through careless placing of light wires. When the blasts are fired by the lighting or power current, it is doubly necessary to observe this caution, because, even with special safety switches, there is always a chance of the workmen becoming confused and connecting the wrong wire. Though the power and lighting current is generally advised for quarry and construction work in the open, the regular blasting machine is much safer in underground work, as by its use the danger of connecting the blast to a live wire can be avoided, and though in open work the number of shots that it is desired to fire at any one time may be in excess of what the blasting machine can do, it is rare indeed that such necessity arises in mining or tunneling operations. By keeping an entirely different circuit for the firing of the blast, much greater safety in operation is secured, but under no conditions should electric drills, electric punchers or undercutters be operated or other wires allowed around a room where men are charging bore holes for electric firing.

**Hang-Fires.**—"Don't hurry in seeking an explanation for the failure of a charge to explode." This is to warn blasters against returning to the face in the event of a hang-fire, until sufficient time has elapsed to render it safe. High-grade safety fuse is a wonderfully reliable device. It is strong, resists abrasion well and stands immersion in water, often for several hours; and it is uniform in its burning speed. Cheap fuse is not regular in its burning rate, is not waterproof and will not stand abrasion against rock in the bore hole nearly as well as the better grades. However, any kind of safety fuse is likely, occasionally, to hang fire.

Accidents happen more frequently, perhaps, from a miscount in the number of explosions. Where 8 or 10 fuses are lighted simultaneously, two will frequently go off at exactly the same time, making one report. Consequently, blasters are inclined to venture back to the face, even if the reports heard do not tally with the number of fuses lighted, assuming that two or more have gone off together. In the event of a misfire, half an hour is the least time that should be allowed before investigating. Two or three hours is much better, and waiting until the next day is practically safe. Hangfires can be eliminated by the use of electric blasting caps and electric squibs, and the increased sales of these devices are gradually cutting down the number of accidents from this cause.

**Precautionary Measures in Case of Misfires.**—"Don't drill, bore or pick out a charge which has failed to explode." A careful miner can sometimes be depended upon to remove the tamping and insert another primer. It is, however, at times safer to drill another hole near the missed one, but this is not practicable in many instances, especially in hard rock, and in "sprung" holes. As a precautionary measure against striking the charge in the case of a misfire, it is suggested that a piece of newspaper or a handful of some other easily recognized foreign substance be placed on top of the last cartridge before the tamping or stemming is done. This acts as an indicator, so that the tamping may be removed with comparative safety without any chance of digging into the explosive.

**Use of Only One Kind of Explosive in Bore.**—"Don't use two kinds of explosives in the same bore hole except where one is used as a primer to detonate the other." It is a common practice in some sections to place a dynamite cartridge in the bottom of a bore hole and the main charge of black powder on top of that, firing the black powder with fuse or squib. The dynamite explodes from the shock of the black powder, but it does not explode as completely as when detonated by a blasting cap, and it is doubtful if any real benefit is obtained. Different explosives have such different rates of detonation that it is not only wasteful but frequently dangerous to use this method of blasting.

**Frozen or Chilled Explosives.**—"Don't use frozen or chilled explosives." Although frozen dynamite is more difficult to detonate with a blasting cap than when it is properly thawed, it is more sensitive to other kinds of shock. Before low-freezing explosives became as generally used as they are today, a number of accidents occurred when men broke the frozen cartridges in two or rolled them to break up the frozen crystals. In loading well drill-holes with large-sized cartridges, a number of thawed cartridges could be dropped into the holes, sometimes 100 ft. or more in depth, with safety. Punching a hole into a frozen cartridge is by no means a safe operation, and the fumes from frozen dynamite are more poisonous than from the same dynamite when properly thawed. In fact, frozen dynamite frequently takes fire from the blasting cap and burns up giving off large quantities of exceedingly noxious gases, which may render the workings uncomfortable if not dangerous to the men.

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*From paper presented at the [illegible]th Annual Convention of the National Safety Council.

**Use Thawed Dynamite as Soon as Possible.**—"Don't allow thawed dynamite to remain exposed to low temperatures; use it as soon as possible." Blasters often attempt to use explosives which have become chilled or partly frozen, and when remonstrated with say that the powder has been thawed. For this reason, they are urged to use dynamite as soon after it has been thawed as possible and to take precautions against it freezing again after it leaves the thawing house.

**Precautions for Storage of Explosives.**—"Don't paint magazine roofs black." On a bright summer day the temperature directly under the roof of the magazine, especially if the ventilation is poor, may rise to as high as 130°. This may cause the dynamite to leak, and the waterproofing on fuse and electric blasting caps to run, so that they will not carry the spark or explode. For the same reason, high explosives, fuse or detonators should not be exposed to the direct rays of the sun longer than is necessary. Sunlight tends to decompose nitroglycerin, as well as to cause it to leak if it becomes too hot.

"Don't keep electric blasting caps, blasting machines or blasting supplies in a damp place." All of these accessories are either spoiled or their life and usefulness are materially abbreviated by damp storage. A blasting machine which is kept in a dry place will be twice as effective as one not kept dry, and the same is true of blasting caps.

"Don't store or transport blasting caps or electric blasting caps with high explosives." High explosives by themselves are fairly insensitive to shock and will withstand an extraordinary amount of rough treatment at times without exploding; whereas detonators are extremely sensitive both to shock and to sparks, and though they are violent in their explosion, effects are local. When they are carried in the same receptacle or transported together there is established a condition combining the sensitiveness of the caps with the far-reaching force and violence of the high explosive. The rule against storing or transporting blasting caps with high explosives is a particularly necessary injunction, and, unfortunately, it is often largely disregarded in mines and quarries where the powder man carries a box containing 20 or 30 lb. of dynamite with a box of caps or a bunch of primers on top of the dynamite.

**Placing Blasting Caps in Cartridges.**—"Don't insert blasting cap or electric blasting cap in explosive cartridges carelessly. Have closed end of detonator point toward the bulk of the charge, and have it tied to the cartridge securely." A large proportion of blasters using electric blasting caps punch a hole diagonally through the side of the cartridge, insert the detonator and take a half hitch around the cartridge with the wires. If the hole is punched through the cartridge at too great an angle, it is likely to go through the cartridge and possibly jam in the bore hole. This would probably lead to a fatal accident. The detonator should lie as nearly as possible in the central axis of the dynamite cartridge, although a slight angle does no harm, provided the end of the detonator is well inside the cartridge. The object in having the detonator point toward the bulk of the charge is that the greatest effect of the detonator is from its loaded end. If the detonator points away from the bulk of the charge, unexploded powder may be deposited in the bottom of the hole and afterward cause trouble. The detonator should always be tied or fastened securely to the cartridge, so that there is no danger of its pulling out when the charge is loaded and tamped. Otherwise unexploded powder or misfired holes may result.

**Precautions in Electric Blasting.**—"Don't attempt to use electric blasting caps with the regular insulation in very wet work. For this purpose secure 'waterproof' or 'submarine' electric blasting caps." This does not necessarily apply where only one shot is fired at a time, but where several shots are fired there is a possibility of electric leakage and short circuits through the ground to the electric blasting cap wires. This results in the under holes and those adjoining going off and the holes in the middle of the line missing fire. "Don't use old or broken leading wire or connecting wire." Broken wires are prolific sources of misfires and failure to get the shot off at the time desired. Breaks inside of the insulation are not easy to detect, and the use of wire that may contain broken sections or strands often costs much more than would new material.

**Precautions for Handling and Using Fuse.**—"Don't handle fuse carelessly in cold weather, for when cold it is stiff and breaks easily. It should be warmed slightly before using." "Don't store fuse in a hot place, as this may dry it out so that uncoiling will break it." The waterproofing material on fuse is a compound of various asphalt tars with guttapercha and similar substances which become brittle in cold weather and which also are likely to run if subjected to too high a temperature. It is well worth while to store the fuse, at least immediately before its use, at a temperature between 60 and 80° F. If the fuse is too cold it may crack when uncoiled and cause a misfire or a hang-fire, with its resulting danger, or, if stored in too hot a place, it is likely to go out and cause a misfire.

"Don't lace fuse through dynamite cartridges, and don't place several slit or broken cartridges on top of primer with cap and fuse. This practice is frequently responsible for the burning of the charge." The paper shell of the dynamite cartridge is sufficient protection against the side spit of the fuse from igniting the dynamite inside the shell. Without this protection the side spit is almost sure to ignite the dynamite, which will burn much more rapidly in a bore hole when strongly confined than it will in the open, sometimes causing the loss of a considerable proportion of the charge, besides giving off poisonous fumes and possibly blowing out the tamping and so making the explosion ineffective.

**Strong Detonators Insure Complete Detonation.**—"Don't expect explosives to do good work if you try to explode them with a detonator weaker than a No. 6." The use of modern low-freezing ammonia dynamites has resulted in an immense reduction in the number of accidents, as those explosives are less sensitive to shock and friction than those in general use 20 years ago. At the same time, these explosives require a much stronger detonator to develop their full power than did the older type of explosives. Although it is possible under favorable conditions to detonate even these modern explosives with weaker detonators than a No. 6, there is a considerable factor of safety gained by using the stronger caps. They not only insure complete detonation, but increase the effective power of the explosive and reduce the amount of noxious fumes to a minimum. Explosives which have been stored for some time under adverse conditions become more insensitive, and a larger detonator tends to offset this condition to a considerable extent. Strong detonators will fire larger charges than weak ones, and they not only reduce chances of misfires, but almost entirely eliminate the chance of a properly primed charge burning instead of exploding. No. 6 or stronger detonators are required for all "permissible" explosives which are not "permissible" unless the strong detonators are used.

## Selecting and Protecting Rope

Care should be used in buying ropes, states Mr. John Upton in a recent issue in The National Builder. A good hemp is hard yet pliant, of a yellow or greenish gray color, and has a sort of silver or pearly lustre. A dark or blackish color indicates that in the process of curing the hemp has suffered from fermentation. Brown spots tell us that the fibers were wet when spun, and are weak. Sometimes good hemp is used for the outside and a poor quality for the inside. This can be detected by making an examination of the end of the rope. Ropes which have a woolly appearance, or where the ends of the fiber protrude, should not be used for important work.

All ropes should be protected from dampness. They can be soaked in a solution of bluestone (copper sulphate). Have your rope dry. Let it lie in the bath for three or four days and then dry thoroughly. Ropes are frequently allowed to unravel at the ends and thus become shorter. If a crown were woven at the end, or even a piece of twine wrapped around it, this might easily be avoided.

# Efficiency Tests of Rock Drill Accessory Equipment

A series of exhaustive tests on rock drill accessory equipment were made last year by Mr. Charles F. Willis, consulting supervisor Phelps-Dodge Corporation, Bisbee, Ariz. Some of the conclusions deduced from the tests are given by Mr. Willis in an article in a recent issue of the Engineering and Mining Journal, from which the matter following is abstracted:

The tests were made on a Paynter rock drill tester, the drill used in the tests was a Chicago Pneumatic Tool Co. stoper

**Pressure Tests.**—In the pressure tests it was desired to ascertain for all pressures the point of maximum efficiency under existing conditions. For instance, it was determined that at 50-lb. gage pressure the machine would not use over 50 cu. ft. of air per min., would not deliver over 960 blows per min., with 240 lb. per sq. in. force of blow, and would deliver only 7 ft.-lb. of energy per blow. It was ascertained that the most economical pressure for this machine was 90-lb. gage pressure. At 100 lb. no greater efficiency was noted, and the cost of compressing the 61 cu. ft. of air necessary for the additional 10 lb. pressure would serve no useful purpose. The tests illustrated forcibly that the first thing for which a rock drill should be tested is the most economical pressure at which it will operate.

**Effect of Temperature and Humidity.**—It was considered possible that there might be some relation between rock-drill efficiency and the temperature of the place where the drill was operating, and to ascertain this a series of tests were made with the room at various temperatures from 70° to 100° F. It was found that the efficiency of the machine was slightly greater at 80° than at 70°, but above that temperature no changes could be observed. The increased efficiency from 70° to 80° was probably due to a loosening of the oil. Humidity tests were run at 70°, 80°, 90°, 100° and 110°, with increasing steam moisture. However, no changes in the results were apparent, and it was therefore concluded that neither humidity nor temperature has any appreciable effect on rock drill efficiency

**Tests of Type and Shape of Gasket.**—The tests proved conclusively that, even with the same size of opening, the most efficient operation of the drill was obtained by a molded gasket with rounded edges. The next most efficient type was a gasket made with a gasket cutter, giving smooth edges, with the cutting perpendicular to the face of the gasket. The third in order was a gasket cut with a knife, particular care being taken to make the walls perpendicular to the face of the gasket. The least efficient was a gasket cut with the walls oblique to the surface of the gasket.

In practice it is found that the most common gasket is the last one mentioned—a gasket hurriedly cut with the knife not held perpendicular to the plane of the gasket rubber. Even in this case it made a difference in the operation of the drill whether or not the gasket was placed with the sharp edge toward the incoming air. To be sure, the relative difference in efficiency is small, but, taken over the period of time that a drill is running, and then multiplied by the number of drills in operation, it shows that a poorly cut gasket is an expensive proposition, and that a molded one, although more expensive as to first cost, is in the end the more economical.

The greatest difference observed by the use of the different gaskets was in the blows per minute recorded. As an alternative, comes the use of the ground-joint union, thus doing away with gaskets. While new, the ground-joint unions were found to be more economical, provided great care was taken to have no leaks, for inasmuch as the particular drill on which these tests were made was not quite 10 per cent efficient, the loss even of 1 cu. ft. of air per min. would make a perceptible increase in the cost of operation. The conclusions derived from the tests made on gaskets indicate as first choice the use of molded gaskets; as second choice, ground-joint unions, and find nothing in favor of the home-made knife-cut gasket.

**Couplings Tests Showed Little Variation.**—Tests were made on 22 couplings of five different types. Experiments showed that in the twenty odd tests made upon couplings no changes in the efficiency of the drill were to be recorded. The tests were negative all the way through, even when the size of the coupling was changed

**Effect of Different Oils on Drill Efficiency.**—Probably the most important of the tests were those made on lubrication. For purposes of comparison the oils used will be denominated A, B, C, etc. With the exception of E, all were California asphaltum-base neutral lubricating oils, scientifically refined and filtered. The gravity of the California oils ranged from 17° to 22° Baumé; the flash test varied from 300° to 340° F.; the fire test from 330° to 410°, and the viscosity from 70° to 220° at 100° Saybolt; E was a Pennsylvania neutral lubricating oil.

The E oil was in many ways the best of the oils tested, giving a greater number of blows per minute and a greater force of blow than any other of the oils included in the tests. The chief disadvantage of this oil, however, was its lack of endurance, probably due to the fact that it is rather a thin product. It is evident that, in order to get its maximum efficiency, not less than 25 c.c. should be fed for every 30 minutes of running time. Particularly noticeable on E oil was the absence of the sticking of the valves that was so noticeable in the other tests. E is an excellent oil for the careful drillman who will not forget to add oil when necessary.

The D oil, during its initial operation, was almost as efficient as E, but fell off rapidly, and even at the end of 15 minutes of continuous operation had lost its real value. D was also a flued oil, entirely too thin for rock-drill lubrication, unless such lubrication were automatic. In this case, however, E would be the better oil.

The oil designated C was the most durable of the oils tested, having virtually as great efficiency at the end of one and one-half hours of continuous running as in its initial operation. While its efficiency was only 80 percent of that of E, at the end of 45 minutes and from then on up to one and three-quarters hours it was much more efficient. C oil should be used at the rate of not less than 25 c.c. for each one and one-half hours of running time.

Throughout all of the tests on oils it was conclusively proved that lack of oil does not mean injury to the rock drill, but only to its efficiency, for insufficient lubrication merely allows it to deliver a less number of blows per minute at a less strength per blow. It is particularly noticeable on C oil that the efficiency is increased in the period between 45 minutes and 1½ hours. This is undoubtedly due to the heating of the drill and the increased fluidity of the oil thereby produced. The increased fluidity is therefore responsible for the rapid drop in efficiency after the rise to the point of highest efficiency.

Next of importance from the point of view of initial operation was B oil, although it had little endurance quality. If this oil is used, it should be fed at the rate of not less than 25 c.c. every 15 minutes. It shows its point of heating and increased fluidity at 45 minutes, although the increase was slight.

The A oil was remarkable for its endurance, maintaining almost a steady efficiency for 1¼ hours, its point of rise, so-called, being at the end of one hour. However, from the point of view of an enduring oil, it was most regular. This oil should be fed at the rate of not less than 25 c.c. every 1¼ hours.

From the standpoint of initial efficiency, E was best, D second best. From the point of view of endurance, C was best, A second best. D had nothing to commend it from either point. Considering the horsepower delivered per c.c. of oil, C excelled the others, largely on account of its endurance, although E, on account of its high initial efficiency, undoubtedly excelled A.

In oil selection it is undoubtedly more important to examine enduring qualities rather than initial efficiency, unless oils of enduring qualities are of low efficiency. The tests have shown that larger quantities of oil than 25 c.c. added at one time are of no additional value, because of the fact that the excess is, in each case, passed through the machine and out the exhaust without serving any useful purpose.

For purposes of comparison two highly recommended rock-drill oils were tested, one of which may be called F and the other G. F proved to be a highly efficient oil, as to initial operation, maintaining its high efficiency for a period of about 10 minutes; had no point of rise due to heating, but at the end of one hour it had entirely lost its efficient action. It was shown to be necessary to feed the F oil at the rate of not less than 25 c.c. every 15 minutes. G, while an oil of high initial efficiency, was also an enduring oil, having its point of rise at 1¼ hours, which means that it should be fed at the rate of not less than 25 c.c. for a like period.

Tests were also made with high-grade automobile lubricating oil, but it was found to be inefficient both in initial efficiency and durability. This fact only serves to emphasize the need of correct selection of oil.

**Air Transmission and Rock Drill Efficiency.**—Tables are available that show what may be expected as to drop in pressure of compressed air passing through pipes and pipe fittings. It was desired to determine whether or not there was any direct or indirect relation between these tables and the action of the drill itself, and experimentation demonstrated that through pipes the relation is direct and corresponds closely to the pressure tests; that considering loss in pressure, caused by certain definite lengths of pipe of certain sizes, the air delivered would give as high efficiency to the drill as that same pressure would if supplied directly. This applied, however, only to straight pipes; the effects began to deviate radically with the use of elbows, for the efficiency of the drill was indirectly related to the fall in pressure created in changing direction of flow. The elbow curves were especially significant. It was found first of all that the air consumption, that is, the cu. ft. of air per minute consumed, did not vary. The relation between the energy delivered in ft.-lb. of energy per blow was directly in proportion to the tables showing the added length of pipe for each elbow of different size. The number of blows per minute, however, varied widely from a direct proportion, and consequently the actual horsepower delivered varied correspondingly. These and other tests demonstrate the fact that friction seriously affects the blows per minute on any drill, while it does not affect air consumption, ft.-lb. of energy per blow or lb. pressure per sq. in. per blow.

**Effect of Elbows on Drill Efficiency.**—Particularly noticeable is the varying efficiency of the drill on the passage of air through elbows of different sizes; although a 1½-in. hose was used, the drill with six 1½-in. elbows was only 60 per cent efficient. If six elbows were to be used, the size should be 1¼-in. elbows to have the drill maintain its highest efficiency, and, even then, the number of blows per minute delivered through six 1¼-in. elbows was lessened.

The conclusions from the tests on air transmission and its relation to rock-drill efficiency were that straight pipe has no other effect than that given in the many tables published, due to loss in pressure, but the other fittings that require the air in passing through them to change direction one or more times have both a serious and detrimental effect. This is more particulary noticeable in the comparison between globe and gate valves.

**Gate Valves Preferable to Globe Valves.**—There is much difference between globe and gate valves in the amount of friction created by the passage of air. It was demonstrated, in the first place, that the amount of air passing through a valve was in direct proportion to the size of the orifice, irrespective of the shape of that opening; but a remarkable variation was observed in the operation of the drill, which was in no way related to the size of the opening but entirely to its shape and the change of direction in the passage of air.

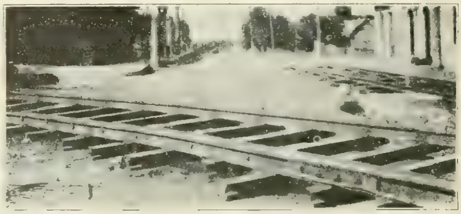
In all the tests there was generally an increase in efficiency by use of a gate valve compared with a globe valve of the same size, particularly with regard to the number of blows per minute and less noticeable as to the energy delivered. This bears out the conclusion as to the relation of friction. It will be noted, however, that the differences in efficiency between the globe and gate valves was greater on the ½-in. valve, and the variation decreased with the increase in the size of the valve, until with the 1¼-in. valve practically no difference could be noted. These facts, however, do not apply to the earliest stages of opening the valves, for, on a ⅛ turn, a globe valve is actually wider open than a gate valve, owing to the lap due to the seating of the gate.

These tests demonstrate the importance of selecting the right size and kind of valves for the passage of air used in rock drills. While it has always been thought that, if a ½-in. hose were used, a ½-in. valve should also be used, this was shown by the tests here recorded to be a fallacy.

# Old Rails Used for Ties in Street Railway Track

In some of the track work in 1916 the Helena Light & Railway Co. of Helena, Mont., employed old rails for ties. The construction is described in The Concrete Highway Magazine, from which the matter in this article is taken.

This decision was reached because the company could not procure a rail 6 in. high and was therefore compelled to use a 4¼-in. rail. But this would not permit more than 2¾ in. of concrete over the ties under the flangeway and it was not considered that this thickness of concrete was sufficient. The company had on hand a considerable quantity of wornout 45-lb. T-rail, which were cut in lengths of 6 and 7 ft. and electrically welded to the track rails, the base of the tie rail to the base of the track rail, as shown in one of the accompanying views.



View of Track Before Placing of Concrete, Showing How Tie and Rail Were Welded Together.

At turnouts the ties were cut long enough so that at the heel of the switch and at the frog, they could be welded to all four rails. Back of the frog for 5 or 6 ft., the ties were extended to reach one rail of the other track, thus giving a very rigid construction.

It was found that track built as above described could not be lined, nor could superelevation be given after the ties were welded. The specifications for concrete pavement required a thickness of 6 in. at the gutter and 8 in. at the center of the street. The depth of track as built was 8¼ in.; 5¾ in. of concrete under the steel tie was considered sufficient. This made the concrete in the street car section 14 in. thick. The mix throughout was 1:1½:3.

Specifications required reinforcement but between rails, reinforcement was placed with heavier wires parallel to the axis of the track instead of transversely. An endeavor was made to bond the concrete to the rails. No weak points had developed in this construction one year after finished, nor do any show at the present time.

So successful were the results of this experiment regarded that when Helena Ave. was paved in 1917, the same type of construction was adopted with but two exceptions. The first was omission of reinforcement, and second the introduction of a longitudinal joint 3 in. beyond the end of ties, the idea being to make the track construction independent of the street pavement. Instead of building the track section ahead of the sides, thus obtaining a straight joint, the pavement was laid full width and when the concrete was struck off with a template, the joint filler was allowed to fall out of line. Joints should be staggered as this eliminates the copper bonds. The ties act as cross-bonds and staggering tends to prevent cracks in the pavement.

The heaviest cars operating over this line weigh 18 tons. The cost per tie in place was:

| | Per tie |
|---|---|
| Salvage of 7 ft. of 45-lb. rail, 105 at 1 ct. | $1.05 |
| Labor, cutting | .05 |
| Labor, welding | .29 |
| Per tie | $1.39 |

# Applications of Conveyors for Handling of Materials

Nowwhere in the industrial fabric has the disturbance brought on by war conditions been more keenly felt than in the unskilled labor market among the shovelers, lifters and movers of goods and materials. Perhaps because this type of labor had always been plentiful and relatively cheap there had been, before the war, less application of machinery to such purposes than in almost any other field.

Ore docks, coal docks, grain elevators, and some large plants were equipped with complete and well arranged conveyor systems. But unless large quantities of material were to be handled in a highly organized way, it was the custom to depend on human labor using very primitive equipment.

Construction jobs, retail coal yards, and factory power plants were examples of undertakings where it would long ago have been practical to install mechanical handling of materials, and where human labor was usually exclusively depended upon.

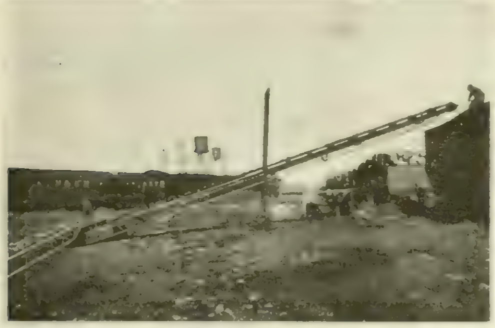


Fig. 1—Portable Belt Conveyors Used in Loading Coke Cars by the Western United Gas & Electric Co. at Joliet, Ill.

War conditions undermined old methods from two directions. Transportation became uncertain and made it essential to receive material in the largest possible quantities whenever transportation was available and store it until it could be used. It was no longer possible to depend on shipments arriving at the plant in such regular sequence that coal or other materials could be unloaded from the cars for immediate use. Storage required more handling, more labor. This increased demand for labor came at a time when the ranks of labor had been greatly depleted by the war demands for man-power, and when all industry was straining to the utmost to produce war materials. High wages and the knowledge that any number of jobs were waiting made the lower grades of labor unreliable and hard to handle.

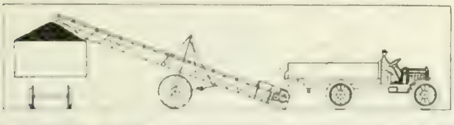


Fig. 2—Sketch Showing How Conveyor is Used to Load a Railroad Car From a Motor Truck—the Truck Dumping Directly Into the Hopper End of the Conveyor.

This situation aroused more interest in light, portable, material-handling machines than ever had been felt before. It became an established principle with many companies not only to replace labor by machinery whenever the machine could do the work cheaper, but to prefer the machine if the costs were the same or even slightly higher.

Light, strong, well-designed portable conveyors, economical of power, easily moved about and set up, made their appearance. They were designed and built in standardized sections that could be assembled in units of any length to meet any requirements. This made it practical to carry at factory for prompt shipments a large stock and held down the investment tied up in such a stock to reasonable proportions.

These conveyors in hundreds of businesses have proved their ability to reduce handling costs from 50 to 90 per cent. Single units have replaced from 3 to 20 men. They were so badly needed that they have paid for themselves, in many cases, in less than a month.

Such portable belt conveyors elevate as well as move material and so have made it possible to use more fully the storage space available. Without additional cost material can be piled to the top of a warehouse or a coal shed, and on the open ground, higher and more compact piling of material is possible. Additional construction of storage buildings can in this way often be avoided.

In the service of the Western United Gas & Electric Co. at its plant in Joliet, Ill., two B-G portable belt conveyors made by the Barber-Greene Company, of Aurora, Ill., are operated in series in loading coke into railway cars. These cars are loaded in from two to four hours, according to size and type, with less than half the labor that was previously required to load them in from 7 to 10 hours. The saving in cost is about 50 per cent. This is typical of results secured by use of these conveyors in many places.

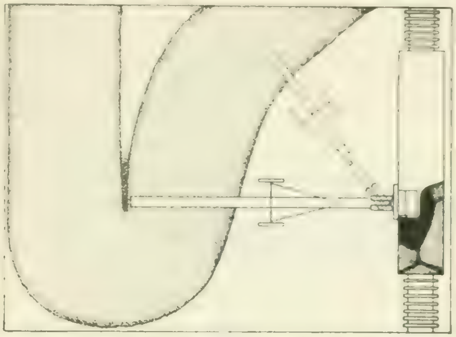


Fig. 3—Sketch Showing How Conveyors Can be Used to Increase the Storage Capacity of Space by High-piling Over the Whole Area.

Several types of conveyors have been worked out to meet different requirements by the Barber-Greene Co. For elevating at angles under 25° a plain belt is employed. For angles of 30° to 35° a belt equipped with steel flights is provided to prevent the material slipping down the grade. For chemicals that will corrode metal conveyors of similar design are provided with wooden frames. The conveyors are made portable by mounting them on a wheeled truck or suspending them from a trolley attached to an overhead steel cable.

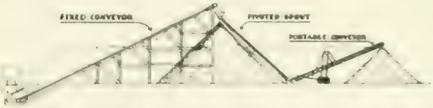


Fig. 4—Sketch Showing the Use of Permanent Conveyor, a Chute and Portable Conveyor for Building Storage Piles Well Back From the Railroad Track

A wide variety of applications has been worked out since these conveyors went into use—many of them unforeseen until they were discovered in practical use. They unload cars into piles, into storage sheds, into wagons or motor trucks. They load cars from trucks or wagons, storage piles or sheds. Where the carry is longer two or more conveyors can be worked in combination—sometimes with a chute between them. A careful study has been made of piling systems and methods developed by which the largest tonnage can be stored on a given amount of surface.

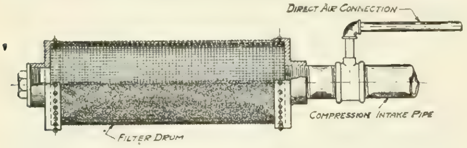
A few methods of applying the conveyor are illustrated in the accompanying drawings.

# Filtered Air Supply for Pneumatic Tools

The desirability of providing a clean air supply for pneumatic tools is pointed out in a recent Standard Practice Bulletin of the Division of Steel Ship Construction of the U. S. Shipping Board Emergency Fleet Corporation. Extracts from the bulletin follow:

One of the simplest and most logical steps in an effort to prolong the life of air tools, as well as the compressing equipment, would include a proper cleansing of the air supply at the compressor intake. Air taken in around the average manufacturing plant is anything but clean, even though the inlet it favorably located, and it is certain that the wear of pneumatic tools is very rapidly increased by dust and grit carried in the air, even when the tools are properly oiled.

Cloth filter screens, if properly designed and handled, will clean the air to a very large extent and can be made to serve the purpose in a very satisfactory way. The larger the filtering area, the closer the grade of cloth that can be used, and the more perfect the filtration. A very open cheese cloth, for instance, placed over an inlet strainer having not more than two or three times the area of the compressor suction pipe would do very little good while a closer woven and more substantial cloth placed over a much larger area will admit the air at a lower velocity, with no more resistance, and will clean it very much more thoroughly.



Drum Construction of Heavy Wire Netting for Compressor Intake Filter.

Careful tests made by the Standard Practice Branch of the Emergency Fleet Corporation show that air will pass through a light grade of unbleached muslin (common unbleached cotton cloth) at the rate of 100 cu. ft. per minute per square foot of area, when subjected to a suction pressure, equal to ¼-in. static head of water, or the equivalent of approximately 1/100 lb. On account of the pulsating action of the air entering a compressor suction pipe, a light cotton cloth filter should be based on a velocity of not more than 1 ft. per second or 60 cu. ft. per minute per square foot of surface.

While the arrangement of a compressor intake filter will depend, more or less, on the particular location and surroundings, it will always be possible to extend the suction pipe outside of the building in the form of a drum, constructed of heavy wire netting, as indicated by the accompanying sketch. The filter cloth can be placed around the drum, or series of drums, where large area is required.

If a supporting layer of poultry wire is secured around the outside of the cloth a large measure of cleaning can be very conveniently accomplished by admitting a sufficient volume of high pressure air directly into the intake pipe and reversing the flow through the cloth, at intervals when the compressor is not in operation. An intake of this type should be protected by hood or shelter to keep the cloth dry.

A plain "U" tube draft gage conveniently located and connected with the suction drum would indicate the resistance imposed by the cloth as it becomes clogged and call attention to the necessity of cleaning.

Air washers similar to those used for cleaning air for the ventilation of buildings should provide an ideal means for completely removing all dust and dirt from a compressor plant air supply.

While the humidity will be increased in the air before the compression during certain weather conditions, it is interesting to note that no practical disadvantage will result, for the following reasons:

Air having a relative humidity of 15 per cent or over, when compressed to 100 lb. and cooled to its original temperature, is fully saturated. Since the air approaching the tools is usually saturated when no washer is used, the only difference will be the quantity of water condensed in the pipes.

The quantity of water condensed in the pipes under the present conditions, gives serious trouble if not properly provided for by the use of separators in the distributing system and an even greater quantity will give no trouble whatever if proper provision is made for its collection and disposal. Hence the difference, except in very dry weather, is a matter of quantity of water to be handled in the pipes and not a difference in the final humidity of the air at the tools.

If after-coolers are used, to precipitate the moisture at the power house after compression, the question becomes one of quantity of water precipitated and, except in very dry weather, conditions in the distributing lines will be identical either with or without air washing.

A study of the pneumatic tool situation at one of the large shipyards showed that the foreign matter carried in the air was of such a nature and extent as to practically preclude the use of the small wire gauze strainers, which belong in the air gun connections, on account of too frequent stoppage. The operators arbitrarily remove the strainers on account of the delays which they cause.

The repair room records in this plant show that more than 50 per cent of all air tool repairs consist of cleaning air parts and working parts affected by the dirt carried in the air. In like manner, a large percentage of compressor troubles, so far as the air cylinders and valves are concerned are directly caused, or aggravated to a large extent, by the dirt.

There is every reason to believe that a proper cleansing of the air supply, together with separating tanks or chambers, located near the distributing headers for the removal of water, pipe scale, etc., will do much to relieve the rapid deterioration of air tools.

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# Gas Driven Locomotive for Industrial Purposes

A standard gage gasoline locomotive designed for the requirements of the mining field and other industrial purposes is illustrated below. This locomotive weighs about 25,000 lb. Its dimensions are: Length, 219 in.; width, 96 in.; height over cab, 132 in.; wheel base 84 in. It is geared for speeds of 4.2 miles and 8.4 miles per hour at a governed engine speed of 700 rpm. The guaranteed draw bar pull on suitable clean dry rail is 5,400 lb. in low gear and 2,700 lb. in high gear. The engine is of the 4-cycle, 4 cylinder, vertical type, the cylinders having a 7 in. bore by 8 in. stroke. The speeds in the transmission are changed by means of jaw clutches with all gears in mesh, obviating the use of sliding gears.

Model L-60 Standard Gage Milwaukee Gasoline Locomotive.

# Precautions for Reducing Accidents on Construction Work*

By W. J. LYNCH,

Assistant to Vice President, Thompson-Starrett Co.

Use only substantial machinery and equipment adapted for the work on which it is used.

Machinery and equipment when returned to the contractor's yard from a job should be given a thorough inspection and overhauling, so that it will be in first-class condition when delivered to a new operation.

Under no circumstances should equipment be overloaded; take no unnecessary chances where human life is in danger.

Where wooden derricks, travelers or timber rigging is used, see that all timbers are in good condition and are erected plumb and square, and that all chains and fittings are securely tied or bolted.

Where stiff-leg derricks are used, see that they are properly weighted. On industrial work, where the derrick is to remain in one location for a considerable time unloading materials, small concrete foundations are sometimes provided—bolts set in the concrete being used to hold the derrick.

In very cold weather unusual care should be exercised not to overload derricks, on account of the action of the cold on the metal parts.

Frequent cleaning of boilers and mechanical equipment serves economy in operation as well as being an important element in accident prevention.

To protect operators from falling materials, provide housing where hoisting engines or motors are exposed.

Crank shafts, gears, and all revolving projections should be encased or other effective protection provided.

Horizontal shafting and hoisting cables should be rail guarded or some danger mark appear in the area in which the shafting or cables are located, to indicate danger to the workmen.

Vertical shafting or cables should be placed in unexposed shafts where possible, but when running through exposed areas should have temporary enclosure for 7 ft. in height, or be rail guarded

The space adjacent to moving cables, engines, etc., should be kept clear of piles of used lumber, rope, rubbish, etc.

Moving cables should be free from chafing against concrete, tile, steel, or other hard material, producing wear.

Where guy cables turn over edge of steel plates or sharp corners, provide wood or other protection against cutting.

The loads should not be thrown too quickly on the motors of electric hoists. This brings severe strain on the hoisting mechanism and may result in burned-out coils.

Cleaning or repairing should not be done while machinery is in motion.

Blocks and sheaves should be selected for the cables used, to prevent undue wear on the cable.

Steam shovels should be kept on as nearly a level bed as possible, to prevent overturning. Special care should be exercised in lifting loads with locomotive cranes when on inclined tracks or curves.

Steam shovels and locomotive cranes should be kept orderly, and miscellaneous parts kept in their places, to eliminate stumbling or tripping hazard.

Only those actually required should be allowed on steam shovels or cranes, and wherever possible workmen should be kept out of the way of the swing of the loads, the operators being instructed to insist upon this precaution.

See that all chains and cables, including rings and hooks in same, are amply strong, the use of steel cable being recommended. Keep machine fittings and cable well oiled and greased. See that all guy cables are securely fastened by substantial clamps. Plates, shackles, chains, hooks, etc., that show any sign of fracture or are badly bent should receive immediate attention, and if liable to be subjected to heavy strain or heavy loads, should be replaced.

Hooks lifting very heavy loads should have either a safety clamp or be securely lashed, to prevent spreading and dropping of load. When lifting heavy loads avoid sharp bends on the cable slings, and when lifting steel use wood blocking to prevent slipping and to prevent abrasion of the cable.

See that the shafts of hoisting engines are true, and clutches, brakes and gears engage properly and work freely.

Riding derrick loads or material hoists should, of course be prohibited.

Material hoists should be guarded with wire or other enclosure on three sides and wood bar at front opening.

Passenger hoists should be provided for workmen, enclosed on three sides and top, with gate enclosure at the opening.

All power saws, planers and jointers should have enclosing guards.

Unless absolutely necessary, workmen should not be permitted to ride on automobile trucks. Many accidents have occurred through falls from overcrowding, hitching on and jumping off trucks in motion.

Men using acetylene torches should use goggles and gloves.

Many accidents occur from the use of defective and worn hand tools. Cracked or insecure handles should be replaced; saws, chisels, etc., should be kept sharp, and hammers and sledges with mashed or fractured heads should be dressed or replaced.

In cutting concrete, wire or other holders should be used to hold the handle of the cold chisel in order to avoid injury when the blow on the head of the cold chisel is misdirected. Tools should not be left lying around to be tripped over or knocked on workmen below.

# The Wages of Railway Technical Engineers

The American Association of Engineers has petitioned the Board of Railroad Wages and Working Conditions of the U. S. Railroad Administration for a special hearing to consider the subject of wages of railroad technical engineers. The association has appointed a committee of representative railroad engineers to assist in gathering and presenting the facts that bear on this case.

The onerous conditions brought upon railroad technical engineers by reason of wages too low to meet living expenses has been brought repeatedly to the attention of the association. One petition from the engineering corps of the Michigan and Logansport Division of the P. C. C. & St. P. R. R. sets forth in a striking manner the wage conditions on that division. According to this petition an investigation of the pay rolls of a contractor who was doing work under the supervision of the engineers of the Michigan Division disclosed the following:

1. The contractor's foreman receives $225 per month as against $136 paid to the railroad company's engineer on construction.

2. The contractor's chief clerk receives $150 per month as against $136 paid to the railroad engineer on construction.

3. The contractor's team foreman, who has charge of 5 or 7 teams, receives $14 per month more than the engineer on construction.

4. The following contractor's employes receive, in addition to the salaries and wages quoted below, time and one-half for overtime and double time for holidays, while no such compensation for overtime is being awarded the engineer, in fact he is not allowed anything whatever for the time in excess of 8 hours he is compelled to work nor for work on holidays.

Steam shovel engineer receives $220 per month.

Steam shovel craneman receives $150 per month.

Steam shovel fireman receives $125 per month.

Dump foreman receives 55 ct. per hour—a higher rate than is paid the engineer in charge of the work, and who is a certified member of the American Association of Engineers.

Track foremen, team foremen (in charge of 6 to 10 teams each), and many laborers receive sums far in excess of the members of the M. of W. corps.

In comparison with the above the following is the list of salaries paid on Michigan Division:

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*From a paper presented Sept. 18 before the Construction Section of the 7th Annual Meeting of the National Safety Congress.

1. Assistant on Engineering Corps; salary, $136 per month; engineer in charge of construction; college graduate; 13 years' experience of which 6 years has been in charge of construction; member of American Association of Engineers.

2. Assistant on Engineering Corps; salary, $123.25 per month; first man on maintenance corps; college graduate; 7 years' experience, 3 years in charge; member of American Association of Engineers.

3. Assistant on Engineering Corps; salary $105.75 per month; 3 years' experience; qualified for American Association of Engineers' membership.

4. Assistant on Engineering Corps; salary, $98.75 per month; 3 years' college; 3 years' experience; qualified for junior membership in American Association of Engineers

5. Assistant on Engineering Corps; salary, $95.90 per month; 17 years' experience of which 13 has been in charge; certified member of the American Association of Engineers

Wages paid in other lines of railway work are cited in the petition as follows: One employe on the Michigan Division, 17 years of age, who has been in the service of the company but a few weeks and whose education had its ending in the fourth grade of the local common schools at the age of 16, for his services as engine oiler during the month of August, 1918, received well over $200. A car repairman on the same division received $205.50 per month. This man formerly drew $75 per month for the same services he now renders. Day laborers working on the coal dock and ash pit receive $112.50 per 30-day month. Helpers in the engine house receive $178.80 per 30-day month. Tool room attendants receive $130.85 per month.

# Mines and Countermines on the French Front*

By CAPT. H. D. TROUNCE.

As soon as the Germans had been halted in their drive in August, 1914, they entrenched themselves, and wherever the trenches of the Allies were within 100 yards of their own they proceeded to start mining across "No Man's Land." Early in 1915 they exploded a large number of mines underneath the Allied trenches. The French and British immediately organized tunneling or mining companies and proceeded to countermine. During 1915 they were mostly engaged on the defensive in these operations below ground, but toward the end of 1915 and in 1916 and 1917 the Allies succeeded in reversing the state of affairs and were active with offensive mining.

When I reached the trenches early in the first week of January, 1916, the British company I was with had succeeded in sinking a number of shafts (not, however, without having several of them destroyed by the enemy during their construction) and had driven a number of galleries well over toward the Hun lines. Our trenches here opposite Fomelles averaged from 80 to 150 yards apart. On account of shallow water level, we averaged a depth of about 25 ft. below the surface, and only by constant pumping with hand pumps were we able to keep up the progress in our galleries. The soil was generally a blue plastic clay. At intervals we would strike running sand, and when this happened we usually found it wise to abandon the drive and start new workings. At the outset many of our tunnels also were destroyed by enemy "blows," but we succeeded in putting in quite an elaborate system in the course of time. The sector we were operating on had a frontage of approximately half a mile, and on this front we had about 16 shafts. From the shafts we drove a complete system of defensive galleries. Our main galleries were about 5½ ft. by 2½ ft. to 3 ft. in cross section; branch galleries about 4½ ft. by 2½ ft. and with listening galleries or "rabbit holes," were usually in the form of a Y from the end of branch galleries and these were used principally for listening purposes.

There is a marked difference between mining in clay and chalk. Later on in the Vimy Ridge area we had considerable mining in chalk. In clay it was possible for the Germans and ourselves to tunnel to within a few feet of each other before we could hear any sound of mining; and elaborate precautions were taken to insure silence. In chalk it is possible to hear from much longer distances, especially where the chalk contained any amount of flint.

To insure silent working in the clay we would use grafting tools instead of shovels. No nails were used in the timbering, all sets being wedged with sand bags. Blankets were hung in the end of galleries to deaden the noise. As we approach nearer to the enemy the men working in advanced tunnels would have to use canvas shoes or work in their socks. No talking was allowed. Every precaution was taken to insure silent work. As the life of every one in the galleries depended on this, the work was conducted almost noiselessly. When we reached within striking distance of the enemy, we would build a charge chamber and load it with guncotton, connecting up with detonators and a double set of leads to the charge, and at the right moment fire these charges from the trench above by means of blasting machines. From this clay soil and at a depth of from 20 to 25 ft., we would blow craters 60 or 70 ft. wide with a small charge of 600 or 700 lb. of guncotton. As a matter of fact, when we met the Hun below ground under "No Man's land we would endeavor to fire "camouflets," that is, a charge calculated to destroy enemy galleries but not to break the surface of the ground. We would usually carry on our work until we heard the Germans talking. When you can hear the enemy talking in clay you can bet they are pretty close. On some occasions we have in this way fired our mines when within three or four feet of enemy mines. In March, 1916, we broke into a German gallery and had a fight with them underground.

Trench mining in clay is much more dangerous than in chalk, on account of the fact I have mentioned—the difficulty of hearing operations until one is almost on top of them. In the chalk country further south, in the Vimy Ridge trenches and the Somme area, we were mining at much greater depths. Some of our mines were 150 ft. deep, and after the battle of the Somme we found the Germans at Fricourt had a mine system 200 ft. deep. For these chalk mines we used a different and much stronger high explosive than guncotton. With the British, we used individual mine charges as large as 100,000 lb. These would blow cone-shaped craters several hundred feet in diameter and well over 100 ft. deep. Some idea of the terrific force of these mines can be obtained when you compare the bursting charge of the Mills bomb, which contains 4 oz., or ¼ lb., of ammonal, with the single mine charges of 100,000 lb., or 400,000 times that amount. You cannot see a hand bomb, like the Mills, burst without having some respect for its destructive qualities—particularly if you are close up.

Nearly all of our work on these Flanders mines was done by hand. At times our galleries and tunnels would be half full of water, and it required constant pumping, day and night, to carry on the operations. Hand water pumps and hand air pumps were used. Vertical shafts were sunk in this clay, usually of case timber, and light pit-prop sets were used for the galleries. All the dirt was handled in sand bags from the face, and brought out from the main galleries on rubber-tired mine cars and hoisted to the surface by windlasses. The sand bags were used for reveting and repairing trenches, which are being continually destroyed by enemy fire and action of the weather, and the surplus bags were emptied at night into shell holes and old mine craters.

We were fortunate, in our work below ground in not losing more men than we did, but it required constant and careful listening to avoid casualties. We could distinguish in time the nature of the sounds of the enemy miners when charging their mines, as distinct from everyday work, and mighty useful it was that we could do so. When we suspected the enemy were about to fire one of their mines, we would warn the infantry and have them withdraw any of their men who were on guard on top at threatened points. Sometimes they would keep us guessing, and would hold their mines, just as we did ours, for several days or even a week or two before firing them. The fact that mining is going on between the trenches is easily established after several weeks' work, but every effort is made to conceal the exact location of the galleries.

*From *The Castle* published at Camp A. A. Humphreys, Virginia.

# Cleveland Considers Broad Reorganization of Its Railroad and Interurban Transportation Facilities

The submission of a new railroad freight and passenger terminal plan to the people of Cleveland to accommodate all roads, including interurban electrics whose traffic would thereby be removed from the public streets to private rights-of-way has brought the city face to face with the question of abandoning the long expected Union Depot along the lake front at the foot of the mall or civic center. The site of the new passenger station as proposed is next to and facing on the public square while the old site contemplated a monumental passenger terminal building on the sightly bluff above the lake, this building completing the architectural plan of the Mall as originally designed by Messrs. Burnham, Carrere and Brunner and later partially carried out by the Cleveland Group Plan Commission by the erection of several monumental city and county buildings and the preservation of site for others conforming to the original Mall plan. The new plan contemplates not only union passenger facilities but also freight houses at the high level of the business district and the co-ordination of railroad entrances under one terminal organization. Cleveland already has voted in favor of the old site. It is now contemplated to place before the voters an initiated ordinance covering the new plan.

The questions involved are so conflicting that numerous civic organizations are studying the two plans and to this end the Chamber of Commerce recently retained Mr. Bion J. Arnold of Chicago to report upon the important features of the controversy, covering an analysis of the comparative advantages and disadvantages of the two plans, the probable result in traffic congestion on the public square resulting from the concentration of seven or more stations into one union station and the practicability of largely organizing the passenger and freight carrying roads and terminal facilities in Cleveland. The most important question propounded to Mr. Arnold for solution is as follows:

"Is it practicable to adjust freight and passenger terminals in this city to the future requirements of a city growing at the rate at which Cleveland is growing and still keep the union passenger station on the Mall site?"

As both the street car and steam passenger traffic is growing so fast as to double in about eight years or less (and in the case of some roads in four or five years), the problem of meeting Cleveland's rapid growth is an important one. The Cleveland district is now estimated to hold nearly 1,000,000 persons and the great industrial expansion is already developing grave problems in housing. New freight facilities are already fully absorbed, their capacity is to be more than doubled, and it is contemplated in the new plan to direct all passenger traffic through Cleveland from the lake front tracks to a new interior right-of-way which is intended to be used also by the various interurbans entering Cleveland. These electric roads handle fully one-half as much passenger business as the steam roads.

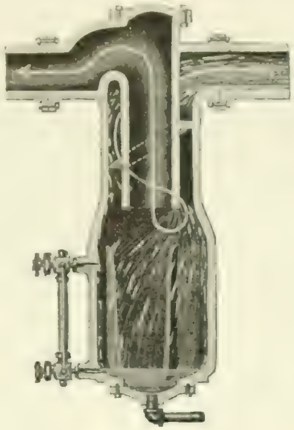
The city is also studying rapid transit and subway development, new viaducts across the valley of the Cuyahoga and the straightening of this crooked stream to facilitate much needed harbor development.

The field survey and development studies of the Arnold investigation are already in progress, in charge of Mr. J. R. Bibbins of Chicago and a preliminary report will be shortly made public at a conference in Cleveland at which city and railroad officials and others prominently identified with this railroad question will be present.

The survey conducted by Mr. Bibbins follows identical lines of similar investigation made in connection with reports of Mr. Arnold on terminal development problems in Chicago, Baltimore, Syracuse, New Orleans and Jersey City, previously published. In these studies, the fullest co-operation and unification of railroad facilities have been urged, not only for passenger but also for freight. It remains to be seen whether such a policy as recommended as Mr. Arnold can now be adapted to the [illegible] conditions brought about by Cleveland's topography and extraordinary growth.

## Separator for Removing Water from Compressed Air

In connection with the operation of pneumatic tools the water which is in the compressed air supplied to them occupies valuable power space in the cylinders of the tools, thereby decreasing their efficiency and sooner or later resulting in damage to the tool itself, due to the constant internal hammering action of the water. A device for mechanically removing water from compressed air has recently been placed on the market by the Griscom-Russell Co., 90 West St., New York. This separator utilizes centrifugal force to remove the water from the air. As the air and water enter it they pass through a helical path formed about a central cylinder, resulting in a swirling motion of the entire mass.



Stratton Air Separator.

As water is several hundred times heavier than air it is thrown out of the curving air current, and against the walls of the separator, which it meets at an angle without any spatter or splash and slips smoothly along until it reaches the receiver space at the bottom. Here the motion is retarded by vanes in order to permit drainage of the accumulated water. It is stated that the resulting separation is complete, with practically no pressure loss. The separator is made of close-grained cast iron, suitable for a working air pressure not in excess of 200 lb. per square inch, is simple in construction, has no movable parts and will operate indefinitely with a minimum of attention.

**Change of Working Hours Reduces Rush Period Congestion**—On Oct. 7, an order issued by the Health Commissioner of New York City, changing the hours of work for offices and business houses went into effect. This order was issued in order to lessen the crowding on the transportation lines during the morning and evening rush hours on account of the prevalence of Spanish influenza. The results of the first four days under this order showed that in the morning rush hours the crowding on the transportation lines was not materially affected but in the evening rush hours a great improvement was noted in that there was much heavier riding between 4:30 and 5 o'clock and less congestion between 5 and 6 o'clock.

**Contractors to Meet Nov. 20 to Form National Association**—The temporary executive committee of contractors formed last July at the Atlantic City convention of Building Industries, has issued a call to all general contractors to attend a convention at Chicago, Nov. 20 and 21, at which time steps will be taken for the formation of a National Association.

## News Letter

### St. Louis Items.

Joe Vorst, St. Genevieve, Mo., wants to buy a second hand 50 or 60-ft. corral tent.

Owen-Block Coal Co., Pattonsburg, Ind., want to buy or lease a small steam-shovel.

Dan C. Crane, Box 411, Springfield, Mo., can use a couple of 10 to 12-team outfits.

D. E. McMillan of the McMillan Contracting Co., reports their work at Delta, Mo., getting along nicely.

Blyth Bros. have their team outfit at work at Union City, Ind., on a piece of the Walsh Const. Co. job there.

Frank L. Aymond is doing some pile driving and bridge work for Butler County, near Poplar Bluff, Mo.

The Walsh Construction Co. commissary and camp at Rock Island, Ill., was destroyed by fire on Monday, Oct. 7th.

L. J. Smith and Scott Mitchell of the L. J. Smith Construction Co., Kansas City, were with us a couple of days last week. Nothing new.

J. W. McMurray Contracting Co. has removed its office from the Sharp Bldg. to suite 511, Railway Exchange Bldg., Kansas City, Mo.

Cameron, Joyce & Co. sublet their drag line work on the Hunt levee near Warsaw, Illinois, to Jobst & Co., Peoria, Ill. About 100,000 yards in this job.

Thos. L. Rosser, Jr., has sublet his steam-shovel work on the Rock Island at Trenton, Mo., to McCullough & Cheney, 440 Temple Court, Minneapolis, Minn.

Contractors when in want of labor or work for their outfits write Koenig Labor Agency, 612 Walnut St., St. Louis, Mo., or 503 Delaware St., Kansas City, Mo.

J. A. Ware has been busy sowing wheat on his big ranch west of the city. J. E. Lyman is taking care of his office in the Boatman's Bank Bldg. here during his absence.

Wm. Ogle, 4700 Goodfellow Ave., St. Louis, has 5 teams, and A. Nason, 26 S. Spring Ave., St. Louis, has 3 teams that they want to place on some grading in this neighborhood.

Thos. Vaughn came in from Cleveland, Ohio, looking for work for his 12 teams and machine outfit which he says will be idle shortly. Vaughn's address is 17525 Kinsman Road, Cleveland, Ohio.

C. F. Nagel will finish his rock contract at La Grange, Mo., in a few days. Nagel will then have a cracker-jack rock outfit and 15 head of stock idle. Is in the market for either rock or dirt work.

The Cook-O'Brien Construction Co., Railway Exchange Bldg., Kansas City, Mo., has been awarded second track work by the Burlington R. R. between Kansas City and St. Joseph, Mo. They have some elegant machine and fresno work to let on this job.

Jas. Burke of the Burke Bros. Const. Co., Ft. Smith, Ark., passed through St. Louis the other day on his way south. They were awarded 30 miles of work on the Louisiana & Arkansas state highway in Ashley County, Ark. Expect to begin work immediately.

John Reynolds, one of the few good old timers, made his appearance in St. Louis the other day. Is going to stay here for a while. Says he has been living quietly on a farm near Booneville, Mo., but is going to get back in the contracting business again. Hard to keep these old fellows out of the game, especially when they put in as many years in it as John Reynolds has. We also wish to state that his brother, Ben Reynolds, whom quite a few people thought dead, is still in the land of living.

A. B. KOENIG.

## Personals

E. G. Lane has been appointed chief engineer of the Baltimore & Ohio R. R., western lines.

Henry C. Westover of St. Joseph, Mo., has been commissioned Captain in the U. S. Engineer Corps.

Fielder Furlow, District Engineer of the Southern Ry., has been commissioned Captain in the U. S. Engineers.

A. H. Freygang has been appointed assistant to engineer maintenance of way of the Baltimore & Ohio, Western lines.

Lt. Col. Henry M. Waite, formerly city manager of Dayton, O., and now in war railway transportation service in France, has been promoted to the rank of Colonel.

Carl Horneman, for several years engaged on engineering works for a railway near Burley, Idaho, has been commissioned first lieutenant in the engineers reserve corps.

Matthew C. Bush has resigned as President of the Boston Elevated R. R. Co., Boston, Mass., to accept the position of vice-president of the American International Corporation.

J. H. Redding, division engineer of the West Jersey and Seashore, has been transferred to the Middle Division of the Pennsylvania R. R., with headquarters at Altoona, Pa. He is succeeded by W. E. Brown, of Elmira, N. Y.

Maj.-Gen. George W. Goethals has been made a member of the war industries board. As director of the division of purchase, storage and traffic of the quartermaster corps, Gen. Goethals works in frequent contact with the board and his inclusion in its membership, it is believed, will be an advantage.

John C. Wrenshall, Jr., division engineer of the Reading division of the Philadelphia & Reading Ry., has been transferred to the New York division, with headquarters at Philadelphia. He will be succeeded by W. D. Kinzie of the Shamokin division, Tamaqua. John S. Goodman of Harrisburg takes Mr. Kinzie's place, and N. W. Schaeffer, supervisor at Lebanon, is appointed division engineer at Harrisburg.

C. E. Haygood, manager of the railway department of the Manila Electric Railroad and Light Company of Manila, Philippine Islands, is visiting the United States on a vacation and for the purpose of consulting with the officers of the J. G. White Management Corporation, New York, N. Y., the operating managers of the Manila Company. He expects to return to the Philippines some time before the first of the year.

R. S. Warner, a banker of Boston, Mass., has been elected vice-president of the United Rys. Co., of St. Louis, Mo. Mr. Warner was born in Kansas City in 1869 and was graduated as a mechanical engineer from Cornell University in 1892. He served 14 years with the Westinghouse Electric Co., then entered the street railway business and devoted much time to organizing, financing and operating public utility companies in Connecticut and Massachusetts. Later he constructed the South Carolina Western, now a part of the Seaboard Air Line.

B. Powell Harrison, for the last 7 years assistant chief engineer of the State Roads Commission of Maryland, has been appointed Harbor Engineer and president of the Harbor Board of Baltimore, Md., to succeed Commander H. Kent McCay, who resigned some time ago to enter the navy. In addition to being Harbor Engineer, Mr. Harrison will be a member of the Annex Planning Commission. Mr. Harrison was born in Virginia 43 years ago, and since his graduation from the Virginia Military Institute in 1896 has had wide experience in engineering work.

F. G. Jonah, former chief engineer of the Frisco Railroad system and now in France with the Twelfth Engineers, has been promoted to lieutenant colonel. Col. Jonah was commissioned as a major in the Officers' Reserve Corps before America entered the war and was ordered to report for duty with the Twelfth Engineers, which was recruited principally from the railroad men of St. Louis and the Illinois side. He took an active part in getting this organization of railroad men equipped and with them left for England July 28, 1917. Last March Col. Jonah was detached from his regiment and given a general command of French railroad maintenance.

## Obituaries

Theodore Steckel, a contractor of Allentown, Pa., died Oct. 4, aged 74.

Julius L. Jacobs, a construction manager for James Stewart & Co., died Oct. 2 at Norfolk, Va.

Harry H. Latham, President of the Latham Machinery Co., Chicago, died Oct. 9, aged 59. He was a graduate of Northwestern university.

Captain N. Simonson, President of the American Construction Co., Cleveland, O., and Perry A. Clapper, Secretary and Treasurer of the Company, died recently. Captain Simonson and Mr. Clapper while returning from a business trip to Lakeside, on Sept. 26th, suffered a serious automobile accident resulting in Mr. Clapper's death on Sept. 27 and in Captain Simonson's death on Oct. 3.

Prof. William Leslie Hooper, for nearly 40 years a member of the faculty of the Tufts College, died Oct. 3 of heart failure, after an illness of a few hours. Prof. Hooper was an electrical engineer of National reputation. He was active in the electrical development of the old West End Railway in Boston and was consulting engineer for a number of traction systems.

James H. Harlow, a farmer and business man of Havre de Grace, Md., died Oct. 6, aged 72. He was a graduate of the Boston School of Technology, and was interested in many public utility companies, being treasurer of the Havre de Grace Electric Co., director of the Baltimore Country Water Co., and director of the Martinsburg (W. Va.) Power Co. He was also largely interested in the Susquehanna Power Co.

Alfred N. Bullitt, a well known construction engineer, of Memphis, Tenn., died Oct. 8. He was assistant chief engineer of construction for the Frisco Ry. from 1894 to 1904, and was chief engineer of the Jackson & Kansas City Ry., Gulf & Chicago Ry., and the Virginia-Carolina Coast Ry. for a number of years. At the time of his death he was just completing a 21-mile macadam highway through Tallahatchie County, Miss.

John C. Robinson, one of the contractors active in rebuilding Chicago after the great fire of 1871, who was afterwards engaged in much of the largest construction in the United States, died Oct. 12 in Santa Fe, N. M. He had been living in the southwest for three years in an effort to regain his health. Among his larger contracts which gave him fame were the building of the Hyde Park water tunnel and the Lake View waterworks, Chicago, the Chicago public library, St. Agatha's church, the St. Louis cathedral, the Kansas City postoffice, the New York customs house, and the Columbus Memorial, Washington, D. C.

John Howe Peyton, President of the Chattanooga & St. Louis Ry., whose death was briefly mentioned in our Sept. 25 issue, was born in Howard County, Mo., in 1864. He was educated at Roanoke College, Salem, Va., graduating in 1881. Shortly after completing his courses at college, he entered the railroad business as rodman on the Richmond & Louisville R. R., and later served in the same capacity with the Richmond & Danville R. R From 1885 to 1888 he was resident engineer for the Lynchburg & Durham R. R., following a brief period of service as instrument man with the Tennessee Midland railroad and the Farmersville & Powhatan R. R. He also served with the Georgia, Carolina & Northern Ry. and became assistant to the chief engineer of the Charleston, Clendenning & Sutton R. R. When the Spanish-American war broke out, Mr. Peyton joined the army and served in the Philippines as sergeant in the engineering corps. In 1901 he severed his connection with the C. & O. Ry. as resident engineer to become chief engineer of the Great Eastern R. R. In 1902 he went with the Louisville & Nashville R. R. as locating engineer. Mr. Peyton had charge of the laying out of the work on the Ridgetop revision which included the tunneling of Baker's Hill, one of the most difficult of railroad tasks by reason of the fact that the work had to be done through solid rock for a stretch of track almost a mile in length. He was also in charge of the construction of the Atlanta division of the Louisville & Nashville. In 1904 he was made principal locating engineer for the L. & N. and served as consulting engineer for the North Coast R. R. From 1909 to 1914, Mr. Peyton served as assistant to Milton H. Smith, president Louisville & Nashville R. R. this time. Mr. Peyton had charge of the building of the Lewisburg & Northern R. R. Early in 1914 he was elected president of the Nashville, Chattanooga & St. Louis Ry.

## Industrial Notes

The Chicago Pneumatic Tool Company announces the appointment of A. G. La Pierre as Traffic Manager and F. O. Southbrook as Manager, Order and Production Department. Their headquarters will be in the home office of the company, Fisher Building, Chicago.

On Oct. 7th and 8th the 30 sales engineers and representatives of the John F. Byers Machine Co., manufacturers of the Byers auto-crane, were called to Ravenna, O., from all sections of the country, for consideration and solution of War Time problems in connection with the distribution of the auto-crane. The joint sales conference and convention ended with motor trip to Cleveland and banquet at the Statler Hotel, Oct. 8th.

*Building and Structural Monthly Issue*

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**Roads and Streets—1st Wednesday**
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies

**Waterworks and Hydraulics—2nd Wednesday**
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power

**Railways and Govt. Works—3rd Wednesday**
(a) Excavation and Dredging (c) Harbors and Docks
(b) Rivers and Canals (d) Railway Construction

**Buildings and Structures—4th Wednesday**
(a) Buildings (c) Ship Construction
(b) Bridges (d) Miscellaneous Structures

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CONTENTS

How Can Competition in Bridge Designing Be Revived? [illegible]
The Leadership of Civil Engineers and Contractors in War Work [illegible]
Should Not All the Merchant Ships of the World be Owned and Operated Jointly by All the Nations? [illegible]
One Necessity That America [illegible] Each Family No More Than [illegible] a Century And Yet of Which [illegible] Used [illegible]
Effective Advertising by a Firm of Engineers and Builders [illegible]
Another Shipbuilding Record Broken [illegible]
Unionization of Engineers [illegible]
A Study of Drafting Room Errors [illegible]
Shipbuilding Progress in United States [illegible]
Working Models of Forms for Reinforced Concrete [illegible] [illegible]
The Am. Soc. C. E. Committee on Development: Its Purpose and Field [illegible]
Method of Building Concrete Barges at Yard of Aberthaw Construction Co. 383
The Objects of Structural Engineering Courses 385
Cost of Concrete Vault for Electric Cable System 385
Cableway With Equalizing Girder Transports Material for Erection of Kettle Rapids Bridge [illegible]
Review of Stucco Tests of Bureau of Standards 387
89-Year-Old Masonry Viaduct Still in Service on C., B. & Q. R. R. [illegible]
Spanish Influenza Hospital That Can Be Erected in 6 Days 389
Salvage Department at Shipyard a Money Saver 389
Expansion Bearings of 1,000-Ft. Continuous Girder, Kettle Rapids Bridge [illegible]
Methods of Repairing Old Stone Masonry 390
Street and Highway Bridge Policy of U. S. Highways Council [illegible]
Local Engineering Society Amends Constitution to Provide for Joint Membership With Other Societies 391
New Regulations of Building Materials Section for Use of Pipes. Tanks Are Accessories in Government Projects 392

# How Can Competition in Bridge Designing Be Revived?

Highway departments as well as railway companies are often in doubt whether to do their own designing of steel bridges or to ask bridge companies to submit competitive designs, for each method has certain economic advantages and disadvantages. Under competitive designing, where the contract price is a lump sum, each bridge company is forced to use its wits to the utmost; and while this has often been the means of securing very economic designs, it has also frequently resulted in unsafe designs. Moreover it usually leads to an excessive duplication of engineering effort that is always expensive—often very expensive.

Competitive designing has all but disappeared in the railway field, and is fast disappearing in the highway field. Nevertheless it should never be forgotten that competition is a very effective means of making men use their brains to the utmost. Even if there is not competition among bridge companies in the designing of bridges, it may still be preserved among the engineers employed by highway departments and railways. And we are inclined to believe that competition should be preserved, at least in a measure.

At one time the editor was engaged in designing and building highway bridges. He was occupied in this manner long enough to learn that even in a field where standardization has been carried out to a high degree, there is still left ample opportunity for the exercise of judgment and ingenuity. He also saw that competitive designing served better than any other means to making designing engineers use their wits.

Now that every state has a highway department, would it not be feasible and profitable to revive competitive bridge designing? Could not the structural engineers of different state highway departments meet periodically and submit their standard designs to a board of consulting structural engineers for criticism?

If this were done and if handsome cash prizes were periodically awarded for the best general designs, and smaller cash prizes for improvements in details, there is little doubt that marked improvements in highway bridge designing would result. Similarly the engineers of the bridge departments of railways could compete periodically for cash prizes.

In designing large, or otherwise special highway bridges, there is also need of competition if the most economic results are to be insured. Here, again, engineers from different state highway departments might well compete for cash awards.

Between the extremes of limitless competition and no competition whatever, some "happy mean" can usually be devised. The cut-throat competition of bridge companies or designers of the bridges that they purposed building was responsible for many evils. But the entire absence of competition in bridge designing is unquestionably responsible for many other evils, not the least of which is crass imitation.

# The Leadership of Civil Engineers and Contractors in War Work

That unprepared America has been able to send 2,000,000 soldiers to France within a year and a half after she entered the war will stand forever as one of the most remarkable achievements in military history. Among the factors that contributed to this achievement none outrank the civil engineers and the contractors of the civil engineering field. It was they who designed and built cantonments to house 1,500,000 men, and did it in three months. It was they who cast aside precedents in ship designing and building, and produced the fabricated steel ship, the great concrete ship, and the new wooden ship of unprecedented size. It was they who designed and built the vast warehouses and docks in America and France—marvels of almost over-night construction. It was they who built a vast railway system in France and had it ready for

Pershing's army before that army was ready to strike its first great blow last summer.

Why was it that architects and architectural contractors did not leap to the front and build the cantonments and warehouses? Why was it that naval engineers and shipbuilders did not show the initiative and boldness of the civil engineers who designed and the bridge builders and contractors who built these new ships? If the answer to these questions is found, in that answer will lie a secret that others will do well to study.

American civil engineers and their associated contractors have, for 80 years or more, been pioneers. Thrown upon their own resources, working in a new country where both men and money were scarce, these leaders in the civil engineering world have learned "how to do that well with one dollar which any bungler can do with two after a fashion," to quote the late A. M. Wellington. American pioneer spirit has been the secret of American progress from the beginning. It permeates almost every class of Americans, but we believe that in no class has this spirit been more active than the class of which our readers form a part. The very outdoor life that so many of us lead in our battles with nature is a life that keeps aglow the spirit of pioneering. Our daily struggles to meet the changing weather conditions, to forestall the effects of floods and snows, have made us resourceful.

Taine, in his great work on English Literature, describes the effect of rigorous climate upon the character, and so upon the literature, of the Anglo-Saxon races. In his Sociology, Herbert Spencer repeatedly points out the effect of climate upon mental and moral development. Fighting difficulties is the exercise that develops mental power, even as battling with the breakers makes the Hawaaians the greatest of swimmers. No class of men in American has been accustomed constantly to encounter greater difficulties than the designers and builders of our roads and railways, our dams and bridges, and all the countless structures that are embraced under the general title of "civil engineering works." The training thus secured, while often bitterly harsh, has made real men of us; so when new difficulties suddenly confronted the nation, we were not merely among the first to assume our share of the burdens. We rushed into other fields and took upon ourselves the burdens that might properly be regarded as belonging to other classes of men.

## Should Not All the Merchant Ships of the World Be Owned and Operated Jointly by All the Nations?

When the world war began the total dead-weight tonnage of merchant ships under all flags was 49,000,000 tons. Up to Sept., 1918, about 30 per cent of this tonnage had been destroyed, but new ships amounting to 20 per cent had been built, leaving a net decrease of 10 per cent, or less than 5,000,000 tons. Had the war not occurred the tonnage would have increased about 20 per cent or 5 per cent per annum. Hence it has been estimated that the world now lacks about 30 per cent of 49,000,000, or nearly 15,000,000 tons. However, any such conclusion is fallacious, for several reasons.

The normal increase in population has not been maintained during the war, and there has been an abnormal setback in the development of international trade. Moreover, the shortage in shipping has so greatly sharpened the wits of men that the average round-trip time or "turnabout" has been greatly reduced. In fact it is estimated that the ton-mile efficiency per annum of the world's merchant ships has been increased fully 25 per cent since the war began. On that basis there will certainly be no shortage of ships within six months after the war ends, and there will probably be a decided surplus.

It is important to reason correctly in this matter, for America is engaged in building ships on a scale never dreamed of before. If our present program is carried out we shall build more than 13,000,000 tons of ships, which alone will add more than 25 per cent to the world's tonnage. Great Britain is also building ships more rapidly than in normal times.

As soon as the war ends Germany will doubtless engage in shipbuilding on a large scale. Japan has been rapidly increasing her output of vessels, and many other countries will do the same. In short, the nations of the world are apparently about to engage in competitive shipping operations on a scale that bids fair to double the total ton-mileage capacity of the existing vessels within a very few years. Unless international trade also doubles within the same time there will be so great an excess of ships that heavy annual deficits will come to all from the operation of ocean freight carriers.

The financial panic of 1873 was largely due to the building of railways in excess of immediate requirements. While no such panic can occur through excessive shipbuilding, at least under Government ownership, still it seems clear that steps should be taken to avoid the great waste that is about to occur through duplication of shipping facilities. Government operation of ocean transportation systems has come, and apparently it has come to stay. The economic question then reduces itself to this: Is duplication of ocean transportation facilities necessary because of the competition of nations in the markets of the world, or can this duplication be avoided by an international pooling of all shipping facilities?

If, as now seems certain, the allies of America in the war will join America in policing the seas and in securing the freedom of the ocean highways, why should the next logical step not be taken at once? Why should the allied nations wait to be taught again the bitter lesson that it does not pay anyone, in the long run, to duplicate a transportation plant that is already adequate? Railway competition is gone never to return on a large scale, if at all. Shall the nations of the world now enter upon an era of cutthroat shipping competition? Or shall they form a joint stock company and operate the entire shipping plant of the world for the common benefit of mankind?

## One Necessity That Annually Costs Each Family No More Than It Did a Century Ago, Yet of Which Twenty Fold Is Used

Of all the necessities of life there is probably but one that annually costs each household no more today than it did a century ago. That necessity is light. According to Dr. Walton Clark, president of the Franklin Institute, the average American family in 1815 used sperm oil and tallow candles that cost $22 a year. This $22 purchased 25 candle-power-hours per night, or 9,000 cp. hr. per annum, from 1815 to 1855. Then came kerosene, which at that time was two-thirds as expensive per candle-power as tallow candles. However, instead of reducing the annual outlay for light, the average family continued to expend about $22 a year for which was secured some 13,500 cp. hrs.

During the decade of 1865 to 1875 the tallow candle was completely displaced by the improved kerosene lamp and illuminating gas; and the average annual cost for lighting each house was about $24. Gas then sold at $2.50 per 1,000 cu. ft., and the family that used gas entirely spent about $34 a year.

From 1875 to 1885 kerosene was reduced to 22 ct. per gallon, and gas to $2 per 1,000 cu. ft. The average family spent $30 a year and secured 76,000 cp. hrs. During the next decade the price of kerosene dropped to 13 ct. per gallon, and gas went down to $1.50; but with this reduction of 40% in prices came a reduction of only 17% in the annual expenditure for lighting, the average yearly cost then being $25 per household.

Between 1895 and 1905 kerosene had practically disappeared in city houses, for gas had not only fallen to $1 per 1,000 cu. ft. in the larger cities, but electric current had fallen to 10 ct. per kilowatt hour. Using electricity at this price and with "carbon filament lamps" the average family secured 50,000 candle-power-hours yearly for which was paid $25.

During the next decade (1905-1915) an astonishing advance occurred in the science of economic illumination, both with gas and electricity. The Welsbach incandescent gas burner which had been invented in 1887 was enormously improved, and coincidentally the mazda or "tungsten filament" incandescent electric lamp was developed.

Today, with gas at $1, a thrifty family can secure 200,000 candle-power of gas light for $15 a year; and a similar family, using electricity at 10 ct., can secure 125,000 cp. hr. of electric light for $18 a year.

Supplementing the foregoing figures of Dr. Clark, the editor is able to say that his appraisals of electric plants and studies of electric rates in many cities, have shown that the average family using electricity spends about $2 a month or $24 a year for light. The $24 ordinarily buys 240 kilowatt-hours; and, using mazda lamps, each kilowatt produces about 1,000 candle-power, so that the 240 kilowatt-hours generate 240,000 candle-power hours. The average useful life of a mazda lamp is 1,000 hours of steady burning or about a year at 3 hours a day, and adding the cost of the lamps (4 yearly) to the cost of the electric current ($20 yearly) enables a family annually to buy 200,000 candle-power hours for $24.

We thus come to two astonishing facts: First, that during the last 100 years, the average American family has not departed widely from an expenditure of $24 a year for light. Second, that the family of today, although spending almost the same sum annually for illumination as was spent by the family of a century ago, secures more than 20 times as much light! This astonishing result is due entirely to American inventors, engineers and business men. So when labor fanatics cry, "Labor produces all and is entitled to all," one may well ask for a definition of "labor." If they include the brain work of engineers, inventors and business managers, well and good. If they exclude that kind of labor—and most of them clearly do—let them be confronted with such facts as these relating to great increases in human productivity that are attributable solely to brain work.

## Another Shipbuilding Record Broken

The launching of a steel ship 261 ft. long, overall, within 14 days after the keel was laid, establishes a world's record. This boat, the "Crawl Keys," was built at Ecorse, Mich., by the Great Lakes Engineering Works. Its beam is 43½ ft. and its depth is 22½ ft. The dimensions indicate a dead-weight tonnage of 3,000. The hull was 93 per cent completed on the day of launching, and 15 days later the vessel steamed away fully completed and ready for service. She bore this sign: "I am 29 days old—Look me over." To make a remarkable achievement still more remarkable, she was not a "fabricated ship" and was built entirely by the company that launched her.

Yes, we are looking you over in the pictures we see of you, but especially should we like to look over the men who built, launched and equipped you in 29 days.

## Effective Advertising by a Firm of Engineers and Builders

"The Austin Company, Industrial Engineers, and Builders, Cleveland, Ohio," is an address that some of our readers have doubtless seen in advertisements in the general magazines. How many readers have asked themselves whether those advertisements might not contain a lesson for them? Here is a structural engineering firm that is doing things, and is telling the public about its doings. Recently it erected a factory building of 58,000 sq. ft. in 30 days, and the fact was given wide publicity. They told why the National Cash Register Co. ordered this "Austin Standard No. 3" factory building and gave out data as to its design. In one advertisement they say: "In 22 working days from date of order The Dayton-Wright Airplane Co., Dayton, Ohio, moved into its fourth Austin Building within the year." In the same advertisement it is added that the Austin record is 120,000 sq. ft. on one job in 30 working days, and 540,000 sq. ft. on the same job in 55 calendar days.

This is a firm of engineers and contractors that believes not merely in doing its work with great expedition, but in telling the world about it. It is one of the few contracting firms at present using general publicity methods. But we predict that its success will stimulate many another similar organization to adopt modern merchandising methods. Although it may sound queer to call the sale of engineering services, or the sales of engineering structures, an act of merchandising, nevertheless it is precisely that.

## Unionization of Engineers

To the Editor: I read with unusual interest the article relating to the organization of engineers into a union, which appeared in the issue of Engineering and Contracting of Sept. 25. I have noticed that the force of articles on this subject is gradually increasing, and I think that the time is not far distant when the engineers will be organized into a union which will bring about a marked increase in salary. It is absolutely necessary that something be done whereby the engineer's salary will more nearly keep pace with his living expenses.

Many good engineers have already gone into other lines of business and others are following as rapidly as opportunities present themselves. One reason why a great many more do not give up engineering for other lines of work is because they are past the age where it is easy to make a successful change. Others feel that they have already spent considerable money for a technical education and have put some of the best years of their lives into engineering, and are reluctant to give it up. Possibly the salary which many good engineers get is not sufficient to enable them to save any money, and they feel that they cannot support a family at a lower salary while getting started in some other work.

About three years ago I wrote an article on the organization of engineers and sent it to Engineering and Contracting, but it was "turned down." Possibly I should not appear to give the impression that I was the only one thinking along these lines three years ago, because I believe that there were many who thought the same way, but hesitated to offer any remedy. The article on this subject last week was well written, and no doubt would have been published had it been presented three years ago.

I am glad that the subject is being so strongly agitated, and I hope that some one will have the executive ability to successfully organize a union among the engineers of this country. Companies who employ engineers, almost without exception, know their value, and would be seriously concerned if they could not get an engineer when he is needed. It is largely the fault of the engineer that he is not paid a better salary, and so long as he continues to underbid his fellow engineer, he will have to suffer for it. When the engineer discontinues this practice, companies will pay him more nearly what he is worth, because they must have him to run their business. I believe a union will educate the engineer so that he will be just to his fellow engineer. No true engineer believes in violence to carry his point, but the right kind of an organization will not resort to this method and will do more toward raising the standard of salaries than organizations who use the methods of violence. He must be fair to fellow engineers in order to succeed. It is the duty of the engineer to provide a decent living for his family. It is almost impossible to do either under present conditions, and it appears to me that organization will solve the problem more nearly as it should be solved.

Minneapolis, Minn. J. C. WORRELL.

# A Study of Drafting Room Errors

By R. FLEMING.

American Bridge Co., New York City.

The most expensive errors in structural steel work are those which must be corrected during erection. In addition to the costs of correction there is often a disarrangement of program and the holding up of other work until the change is effected.

Drafting errors occurring most frequently and which may be classed as "typical" are: coping omitted, insufficient clearances, right and left neglected, beams fouling rivet heads, and field holes not matching. From reports of 935 corrections made in the field there are taken the following:

Bevel shown wrong way.

Holes staggered wrong.

Columns had holes for knee braces 3½ in. gage, while in knees they were 3¾ in. gage.

Rivets countersunk on wrong side.

Rivets not countersunk.

Marks were wrong. (It took a locomotive crane 16 hours to redistribute.)

Girders were not coped to clear stiffeners. (Erection was tied up while coping was done.)

Angles should have been right and left.

Column made wrong hand.

Girders should have been made in pairs.

Holes in girders made opposite hand when they should not have been.

Bottom flange of beams fouled heads of rivets in girders.

Beams could not be set in place on account of projecting rivet heads.

Lug on columns at 5 floors projected through the fireproofing. (Had to be burned off with flame.)

Sufficient clearance not allowed for overrun of angles.

Rivets could not be driven in flanges of girders on account of stiffening angles.

Beams not coped back far enough.

A second class of errors may be termed "sporadic." These happen in unexpected places and can not well be explained unless mental processes can be reviewed. The man making them is liable to aberrations but usually after two or three serious mistakes is eliminated from further work.

The most expensive single errors come from a change in either design or detail not being followed throughout. Girders have had flange areas increased without changing the spacing of rivets. In two cases columns were turned 90° without changing the anchor bolt or grillage plan. The use of the "do" mark has often involved considerable cost. One instance is that of a light highway bridge in which the top chord pins were all the same diameter. After the work had been commenced in the shop it was decided to make the hip pins a trifle larger. The draftsman changed his drawings but forgot to change a "do" mark on the pin list. The result was that an erection gang in a remote country place had to idle away time until six new pins could be made and shipped by express. Cases might be cited where single beams in the floor plans of buildings have been made lighter or heavier without changing the "do" mark for the beams following. It is a question whether or not the "do" mark should be used at all on drawings.

It is a man's job to follow a change throughout, whether made in design, details or contract requirements. Changes should be made on dependent drawings as well as those affected directly. All prints sent to the shop previously should be destroyed. Prints sent to outside parties should be recalled. File prints should be marked "See revised print" and the new print should give the date and nature of the revision.. The failure to take these precautions has often been a source of annoyance and expense. Almost at the date of writing these lines word comes in that on one job the bracing in the sides of a building interferes with the ventilating sash. The architect had not sent prints of his revised elevations. At another site there are some steel rolling doors 2 ft. too wide because the owner neglected to notify the door contractor that the drawing sent him had been changed. A few years ago the corrections for an expensive error had to be made in the field. When a duplicate structure was wanted two or three years later the same error was repeated because the corrections had not been noted on the file drawings.

The cause of many errors may be attributed to carelessness. "A careless draftsman" is often given as sufficient reason for vexatious delays. Yet mistakes are made by careful men. This is often because the draftsman and checker lack a sense of proportion. They give the same degree of attention to the spacing of shop rivets in columns as to the matching of field holes. They forget that an error in spacing will be caught in the templet shop, but that one in field holes may not be found until the pieces are assembled at the site. They give the same attention to a field connection that is not duplicated as to connections that are repeated scores of times. In one contract 54 beams had the end holes 6½ in. apart while the holes in the girders to which they were to be bolted were spaced 7 in. In another contract the holes in the roof purlins did not match those in the angle clips on the trusses. These instances illustrate that expensive errors often occur where seemingly there is no excuse. Skew portals of bridges and complicated hip and valley roofs seldom cause trouble, but some simple bracing member is often either too short or too long.

Can drafting errors be eliminated? To the late James Mapes Dodge it attributed the remark, ". . .. but never attempt to be 100 per cent efficient." "Accuracy in the abstract may be regarded like 100 per cent efficiency, as a nearly impossible ideal. But accuracy up to a well-defined limit is an entirely attainable end."*

The magnitude and importance of the work will determine these limits. The Hell Gate arch demanded a much more elaborate system of checking than that necessary for the ordinary industrial building. Assuming that the average cost of correcting drafting room errors in the field is 5 ct. per ton, it would be unprofitable, to say nothing of time or delay, to spend $100 for double checking an ordinary building of 1,000 tons.

To make sure of field holes matching, one contracting firm has all field connections rechecked.

If a distance is given correctly half a dozen times and wrong once, the wrong one is liable to be followed. To avoid this, the plan was tried in a designing office of giving a distance but once. It was, however, found to be impracticable and was abandoned.

The practice in one large drafting room is to be commended: Blue prints of erroneous details are posted as they are reported, together with the outlines of correct details and notes by the engineer in charge. It might also be good practice to post bills for remedying errors. Most draftsmen know little of the cost of field work.

It is always profitable to take time to consider how to correct a mistake. A recent instance may illustrate. At the site some grillage girders could not be brought together in pairs as was intended because the stiffening angles extended beyond the flanges. To cut an inch off the outstanding leg of each stiffener, as was proposed would have cost $700. A careful study of actual requirements and action in accordance therewith reduced the cost of changes to less than $100.

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**Briquets Made of Coal Dust and Cement.**—A method of utilizing coal dust and fine slack for fuel purposes is described in a report of the Advisory Committee of the British Coal Controller. According to this scheme accumulations of fine coal dust should be carefully mixed with cinder, sawdust, small wood chips, and 10 per cent of cement, with sufficient water to render the whole plastic. Mixing should be done on a stone or concrete floor. When thoroughly mixed, the material should be rammed into ordinary flowerpots (a convenient size being 4½ in. high by 3½ in. diameter at the top) and then quickly turned out on a board to dry. Fuel cakes or briquets thus made should be left for one week in a dry place to harden.

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"Relative Accuracy," William S. Ayers, American Machinist, Vol. 46, p. 457, March 15, 1917.

# Shipbuilding Progress in United States

Interesting information regarding the progress of the U. S. Shipping Board construction plan and the relative rate of ship building in this and allied nations is given in a bulletin issued last week by the information bureau of the Shipping Board. Extracts from the bulletin follow.

**Tonnage Controlled by Shipping Board.**—Within the jurisdiction of the United States Shipping Board at the present time (Sept. 1, 1918), there are 2,185 seagoing vessels totaling 9,511,915 dead-weight tons. Of these 1,294 totaling 6,596,405 dead-weight tons, fly the American flag. Under charter to the Shipping Board and to American citizens there are 891 foreign vessels, totaling 2,915,510 dead-weight tons. At the time the United States entered the war the American merchant marine included approximately only 2,750,000 dead-weight tons of seagoing vessels of over 1,500 dead-weight tons. The expansion of the fleet within the jurisdiction of the Shipping Board has come about for the most part during the past year.

**Expansion of Our Merchant Marine.**—The American merchant marine is today expanding more rapidly than any other in the world. In August of this year the United States took rank as the leading shipbuilding nation in the world. It now has more shipyards, more shipways, more shipworkers, more ships under construction, and is building more ships every month than any other country, not excepting the United Kingdom, hitherto, easily the first shipbuilding power. Prior to the war the United States stood a poor third among the shipbuilding nations.

Since August, 1917, more seagoing tonnage has been launched from American shipyards than was ever launched before in a similar period anywhere. The total, as of Sept. 1, 1918, 574 vessels, of 3,017,238 dead-weight tons, is nearly four times all the seagoing tonnage (of over 1,500 dead-weight tons) built in the United States in any four prewar years. The total launchings since the first of this year, 482 vessels, of 2,292,692 dead-weight tons, are more than eight times the seagoing tonnage (of over 1,500 dead-weight tons) produced in this country in any prewar year.*

In the first year (August, 1917—August, 1918) of the present Shipping Board the following ships were launched:

| | Number | Dead-weight tons |
|---|---|---|
| Wooden ships | [illegible] | [illegible] |
| Composite ships | [illegible] | [illegible] |
| Steel contract ships | [illegible] | 708,[illegible] |
| Requisitioned [illegible] | [illegible] | [illegible] |
| Total | [illegible] | [illegible] |

**Deliveries of New Ships.**—More than 2,000,000 dead-weight tons of new ships have been completed and delivered to the Shipping Board during the past year. The first delivery was made on Aug. 30, 1917, by the Toledo Shipbuilding Co., of Toledo, O. The first million tons of completed ships were obtained in May; the second million in August. The deliveries to the Shipping Board in August broke all world's records in the production of ocean-going tonnage and established the United States as the leading shipbuilding nation of the world. They totaled 338,983 dead-weight tons. Those from American shipyards to the Shipping Board in August totaled 313,380 dead-weight tons, exceeding the previous world's record for any month, which had been made by British shipyards in May, 1918, by 17,869 dead-weight tons. The deliveries to the Shipping Board by American shipyards from Aug. 30, 1917, to and including Aug. 31, 1918, totaled 325 seagoing vessels of 1,941,875 dead-weight tons. Adding 8 vessels of 66,357 dead-weight tons delivered by Japanese shipyards, the grand total of deliveries to the Shipping Board up to Sept. 1, 1918, was 333 vessels of 2,008,232 dead-weight tons.

The deliveries to the Shipping Board from American shipyards in 1918 to Sept. 1 in comparison with the output for the same period by British shipyards show up as follows:

| [illegible] | [illegible] | [illegible] |
|---|---|---|
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| April | [illegible] | [illegible] |
| May | [illegible] | [illegible] |
| June | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| Total | [illegible] | 1,546,161 |

To date American shipyards lead by 79,981 tons.

**Records Made by Shipyards.**—The most spectacular achievement in the history of shipbuilding, in this or any other country, was the launching from American shipyards on Independence Day of 95 steel, wood, and composite vessels, totaling 474,464 dead-weight tons. Thus in one day there were launched 188,909 dead-weight tons more than the output of seagoing tonnage of over 1,500 dead-weight tons) in the best prewar year of American shipbuilding.

Another world's record was made by American shipyards for the month of July. There were launched in that month 126 steel, wood, and composite vessels, totaling 634,411 dead-weight tons. This total more than doubles the launching totals for any month in the history of British shipyards. Before the war British shipyards launched more vessels annually than all the others in the world.

An unprecedented pace of construction marks the rapidly increasing output of tonnage from American shipyards. All records for fast shipbuilding are now held by them. Before the war from nine months to a year were required to build a 3,500-ton steel seagoing vessel, from a year to year and a half to build a 5,500-ton steel vessel, and from a year and a half to two years to complete a vessel of 8,000 tons and over.

In July and August of this year only 34 calendar days elapsed between the keel laying and delivery of the 3,500 dead-weight ton steel freighter Crawl Keys. This world's record was made by the Great Lakes Engineering Works, of Ecorse, Mich. The keel of the Crawl Keys was laid on July. The vessel was launched in the record-breaking time of 16 calendar (14 working) days. On August 13 the Crawl Keys was completed, and on the following day it was accepted by the Shipping Board and placed in commission.

Only 37 calendar days were required in May and June to build the Tuckahoe, a steel collier of 5,500 dead-weight tons. This sensational pace for war-time shipbuilding was set by the New York Shipbuilding Co., of Camden, N. J.

A world's record was made when the Tuckahoe was launched 90 per cent complete on June 5 in 27 days 2 hours and 50 minutes from keel laying. Another world's record was made 10 days later when the Tuckahoe, ready for service, was delivered to the Shipping Board. The Tuckahoe was carrying coal to New England on the fortieth day.

The 10 fastest built seagoing vessels in the world have come from American shipyards this year. They are:

[illegible]

[illegible]

West Lianga, freighter, 8,543 dead-weight tons, Skinner & [illegible]

[illegible]

West Hobomac, freighter, 8,604 dead-weight tons, Skinner & [illegible]

[illegible]

West Cohas, freighter, 8,554 dead-weight tons, Skinner & Eddy Corporation, Seattle, 85 (calendar) days.

West Gambo, freighter, 8,554 dead-weight tons, Skinner & Eddy Corporation, Seattle, 86 (calendar) days.

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*[illegible]

[illegible] Navigation, which, like the British Admiralty, lists all vessels of over 100 gross tons.

West Ekonk, freighter, 8,554 dead-weight tons, Skinner & Eddy Corporation, Seattle, 88 (calendar) days.

West Alsek, freighter, 8,529 dead-weight tons; West Apaum, 8,516 dead-weight tons; and West Gotomska, freighter, 8,586 dead-weight tons, Skinner & Eddy Corporation, Seattle; and Lake Gardner, 2,300 dead-weight tons, Great Lakes Engineer Works, Ecorse, Mich., 92 (calendar) days.

The speed that American shipbuilding has attained this year is further shown by the following launchings made in record time:

Manitowoc Shipbuilding Co., of Manitowoc, Wis., launched the 3,400-ton steel freighter Corsicana on Aug. 7, 28 (calendar) days after keel laying.

Bethlehem Shipbuilding Corporation, of Alameda, Cal., launched the 12,000-ton freighter Invincible on Aug. 4, 31 (calendar) days after keel laying.

American Shipbuilding Co., of Cleveland, launched the 3,550-ton steel freighter Lake Narka on May 4, 46 (calendar) days after keel laying.

Baltimore Dry Dock & Shipbuilding Co., of Baltimore, launched the 6,450-ton steel refrigerator ship South Pole on June 17, 46 (calendar) days after keel laying.

Bethlehem Shipbuilding Corporation, of Alameda, Cal., launched the 12,000-ton steel freighter Defiance on July 4, 46 (calendar) days from keel laying. On the same day this yard launched three other 12,000-ton steel freighters, one of them, the Victorious, 66 (calendar) days from keel laying.

**Shipyards and Shipways.**—When the present Shipping Board began its work, in August, 1917, there were only 61 shipyards in the United States. There were 37 steel shipyards with 162 ways. About three-quarters of their capacity had been pre-empted by the naval construction program, while private orders overflowed the remaining ways. In the 24 wood shipyards there were only 73 ways.

The largest shipyards in the world in September, 1918, are those of the United States. The Clyde River, in Scotland, historically famous as the greatest of all ship building localities, is already surpassed by two ship building districts on the Atlantic Coast and by two on the Pacific Coast—by Delaware River and Newark Bay in the east and by Oakland Harbor and Puget Sound in the west. One yard, Hog Island, on the Delaware, is equipped to produce more tonnage annually than the output of all the shipyards of the United Kingdom in any prewar year. It has 50 ways.

There are now 203 shipyards in the United States. The list comprises 77 steel, 117 wood, 2 composite, and 7 concrete shipyards. Of these, 155 are completed, 35 more than half completed, and only 13 less than half completed. The great plant at Hog Island is 95 per cent completed—built in one year. Its site, when the United States entered the war, was a swampy marsh.

Every month of the past year has added to the number of American shipways, until today the impressive total is 1,020—more than double the total of shipways in all the rest of the world. Of the 927 shipways that are for the Emergency Fleet Corporation of the Shipping Board, 810 are listed today (Sept. 11) as completed, and only 117 are to be added. There are 410 completed ways for the construction of steel ships, 400 completed ways for the construction of wood, composite, and concrete ships.

**Employes.**—The records of the United States Shipping Board Emergency Fleet Corporation show that there are now approximately 386,000 employes in the shipyards. There were less than 50,000 shipworkers in July, 1916. The weekly pay roll of the shipyards building ships for the United States Shipping Board is $10,500,000.

**Program and Contracts.**—Here is the program of ship construction which the Shipping Board has placed with the rapidly expanding shipyards of the country:

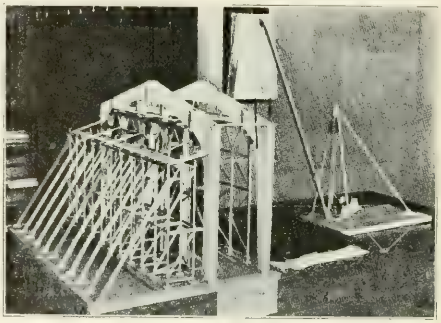
| | Dead-weight tons. |
|---|---|
| 2,249 contract ships, totaling | 13,212,712 |
| 42 concrete ships, totaling | 301,500 |
| 402 requisitioned ships, totaling | 2,790,792 |
| 2,693 ships | 16,305,004 |

The Shipping Board has also contracted for the construction of 170 wood barges, 279 steel, wood, and concrete tugs, 100 trawlers, and 25 harbor oil barges, totaling 50,000 dead-weight tons.

# Working Models of Forms for Reinforced Concrete Buildings

The advantages of employing a working model of forms for reinforced concrete buildings are pointed out by Mr. T. M. Lauridsen, Form Designer for Villadsen Bros., contractors, Salt Lake City, Utah, in the Journal of the Utah Society of Engineers. He states that both drawings and models are advisable for work of exceptionally large dimensions, or work in which untried methods are necessary, especially if the forms represent a considerable investment. The illustration shows the model form design for a foundry which has 14 bents the same as the two shown in the model. They have a span of 69 ft. and a height of 44 ft. The form is designed for use three times. The end scaffold is not only to provide a solid backbone for the whole form structure, but also for use in setting steel sash, pouring end wall, stripping and painting. The best position for the scaffold may be exactly determined from the model, so that it is available for all the different kinds of work and will not have to be reconstructed for each.

In a building of this kind, where new methods are to be used, it is frequently found that the first part of the work is more or less experimental, and the most effective working methods are only developed by the time the last bent is reached. By the experience gained in putting the parts together in the form of a model, it is expected that almost as much efficiency will be attained on the first bent of this building as is usually the case on the last bent. For instance, before the model was constructed, it was thought that it would be advisable to erect the outside scaffolding first. A study of the model developed the fact that a saving of possibly 10 per cent in the erection of the first bent might be made by erecting the scaffolding under the bent first and following that with the end scaffold, thus allowing a clean sweep for the erection of the arch supports, which are exceptionally heavy.



Design of Model for Form Work.

Another point which was very easy to observe from the model, but was not by any means so evident from the set of drawings, was the necessity of eliminating all the diagonal sway bracing on one side of the arch scaffold, so that the column forms would go into place more readily.

It should be noted that the model is supplemented by a most complete and detailed set of form drawings. This method of representing the building in its whole three dimensions at one glance serves as an excellent check on the form drawings.

**Precautions in Cold Weather Concreting.**—In the construction of the Third Ave. bridge of Minneapolis, Minn., a considerable part of the 27,000 cu. yd. of concrete in the piers was placed when the temperature was below zero. For this winter concreting the forms were entirely enclosed by tarpaulins and heated by coke fires. The concreting buckets also were warmed by dipping them in hot water before filling them with concrete.

# The Am. Soc. C. E. Committee on Development: Its Purpose and Field

The Committee on Development of the American Society of Civil Engineers created under the resolution adopted June 18 last (see Engineering and Contracting July 17), by the Board of Direction of the Society, has been selected. It consists of 28 members of which the following were appointed by the President of the society: Onward Bates, chairman, Chicago; Paul G. Brown, New York City; Charles Hansel, New York City; Clifford M. Holland, Brooklyn, N. Y.; Frederick C. Noble, New York City; H. R. Safford, Montreal, Que.; S. Everett Tinkham, Boston, Mass. The remaining 21 members and the local associations by which they were appointed follow: Richard L. Humphrey, Philadelphia Association; J. C. Ralston, Spokane Association; Robert A. Cummings, Pittsburgh Association; George R. Putnam, District of Columbia Association; Baxter L. Brown, St. Louis Association; William H. Hoyt, Duluth Association; George C. Mason, Portland, Ore., Association; H. L. Haehl, San Francisco Association; George G. Anderson, Southern California Association; E. B. Thomas, Cleveland Association; Edgar S. Nethercut, Illinois Association; W. L. Darling, Northwestern Association; John L. Hall, Seattle Association; Arthur Pew, Atlanta Association; J. H. Brillhart, Texas Association; Thomas L. Wilkinson, Colorado Association; Charles J. Tilden, Baltimore Association; Arsene Perrilliat, Louisiana Association; Frank T. Darrow, Nebraska Association; George Butler, San Diego Association; Gardner S. Williams, Detroit Association.

The following precept for the general guidance of the committee has been prepared by Prof. Arthur N. Talbot, President of the society:

**Purpose and Scope.**—It is intended that the committee on development shall make a survey of the fields of usefulness which are or should be open to the society, consider what functions may properly be assumed by the society, define its purposes, formulate policies and methods of work to be recommended, and consider the needs in organization and constitution. This means taking stock and making plans. The resolutions contemplate an examination of present-day conditions and an outlook into the future. They involve considering the changing social and industrial relations of the times and the opportunities and responsibilities which devolve upon the society and its membership. The relations of the society to other societies and to the profession generally are also included. The outcome of the work of the committee may be modifications in the activities, functions, and methods of work, or in the emphasis in these matters, and possibly the addition of new ones. Naturally the resolutions assume that the views of the membership of the society will be asked for and its aid obtained in determining what the society's purposes and activites should be and how they may best be carried out. It is expected that the committee will report definite recommendations in the field of its work and these recommendations may include proposals of fundamental changes which may involve amendment of the constitution of the society.

**The Committee's Field.**—It would be premature to outline the ground to be covered in the committee's work; this may best be found by the committee as its work progresses. It may serve a good purpose, however, and aid in starting effective deliberations more promptly if some expression is made of the possible content of the work. With this advantage in mind the following is suggested as representative of the field of the committee's work:

1. Relations of the society and its membership.
    (a) The relations of the society to its membership and to the profession of engineering.
    (b) The relations of the society to other engineering societies and to related organizations.
    (c) The relations of the society, its membership, and the members of the profession to public affairs, to the welfare of its members and the public, to the [illegible] of [illegible] and [illegible] and to movements of times related to industry and society.
2. Organization of the society and the profession.
    (a) The functions of the central organization of the society and its relation to other organizations.
    (b) The functions of the local associations of members (including the membership at New York) and their relations to the society, to other societies, and to groups of organizations.
    (c) The organization of the engineering profession as a whole.
3. Technical activities of the society and its possible branch organizations.
    (a) Meetings, papers, publications and committee work.
    (b) Activities related to engineering progress and engineering problems.
    (c) Sections or divisions of the society for specialized lines of work.
    (d) Co-operation with specialized engineering societies and other organizations.
    (e) Relations to other technical activities such as those of the proposed standards committee.
4. General acitivies of the society and its possible branch organizations and co-operative organizations.
    (a) Activities related to public affairs and public welfare.
    (b) Activities related to the welfare of its members.
    (c) Relations to organizations dealing with industrial and governmental problems.
5. Functions of the society in relation to the younger members of the profession and to those in executive, contracting and other lines.
6. Miscellaneous needs of the organization.
7. Proposals for changes which will involve making amendments to the constitution and formulating rules and methods of procedure.

These general topics, which are mostly self-explanatory, are necessarily interrelated in a variety of ways. The subject of the relations of the society to its membership, the profession, the public, and the times involves questions of the purposes, functions, and organization of the society. The organization topic relates to ways of managing activities and functioning with other organizations. The technical activities topic embraces means for carrying on the technical functions of a great engineering society, contributing to engineering knowledge, creating or developing new engineering policies, originating and bringing about constructive, progressive, movements, and developing engineering practice and engineering influence. The general activities topic relates to the work of the society in connection with public affairs and the welfare of the profession and of society. The functions of the society with reference to the classes of members of the profession are bound up intimately with the topics already referred to. It will be noted that this outline of the field of work of the committee is not in the form of a program of work or order of procedure; the topics are too closely related to make it applicable to such uses.

Certain matters of policy which have been called to the attention of the board of direction have been referred to the committee, such as the rewriting of the code of ethics of the society, the suggested organization of American engineers abroad and the question of what policy the society should take toward the adoption of standards, and doubtless other matters will be so referred. It seems probable that many members of the society will have proposals which they will desire to present.

**Formulation of Policies and Determination of Methods of Execution.**—The great questions before the committee, then, are (1) what are the functions which the American Society of Civil Engineers should assume and (2) how should they be carried out.

It goes without saying that a society should consider and determine the functions it will undertake and the working policies it will pursue. In considering these matters, it is apparent that the formulation of a proposition is a step which may aid in judging of the value of the proposal, since the mere attempt at making the statement may bring out its impracticability or its undesirability. The formulation of propositions, too, takes the mind away from indefinite generalities and to definite proposals which should have much the same significance to all readers. It will be evident, too, that some proposals must be accepted only as principles or ideals and not as working rules, and a distinction between these two classes may well be made. Definiteness of statement of course is essential in a report of a committee such as this. Doubtless the committee will carefully consider functions and policies and their formulation.

Not less essential is the determination of the methods and ways of executing proposed functions and carrying out policies. In devising administrative plans it is well to keep in mind that organization should be left as simple and flexible as possible; elaborate or complicated organization and methods are likely to be ineffective; they are not self-propelling; and time makes changes in needs and scope of work.

In the course of its work the committee will doubtless find it desirable to consider whether changes should not be made in the constitution of the society, even though, as has been found true in the past, changes in methods and new activities may be put into effect without amending the constitution; the securing of the views of the membership of the districts on their choice for members of the nominating committee and the establishment of engineering council are examples of what has been done without modifications of the present constitution. It seems likely, however, that the committee will want to recommend ways in which the constitution should be changed. Here again it is suggested that simplicity, flexibility, and breadth should be kept in mind, and that details be left for by-laws and regulations. It will be necessary to learn whether proposals for activities and methods come into conflict with the charter or conditions of incorporation of the society. Possibly the conditions governing the incorporation may limit somewhat activities which the committee may think desirable and possibly the committee may conclude that modification in the articles of incorporation should be made or other steps be taken to give legal strength to their recommendations.

**Co-operation with Committees of Other Societies.**—Proposals have been made that the other national engineering societies appoint committees to take up similar work for those societies. In case such committees are formed it will be the duty of the committee on development of the American Society of Civil Engineers to co-operate with these committees on subjects of common interest. The committee may also find it desirable to confer with representatives of local engineering societies over the country concerning the relations which the American Society of Civil Engineers and its local associations should bear to these local societies. It would appear that much may be accomplished through conferences with both national and local organizations.

**Committee Procedure.**—The committee is so large and so widely distributed over the country that its work may best be done partly by correspondence and written discussion, partly through sub-committees, and partly at meetings of the whole committee. To ensure that adequate progress be made at the first meeting of the committee, it is important that preliminary work be done in advance of the meeting. This may well cover matters relating to the field of work, to the organization of the committee, and to proposals for the committee's consideration. At the first meeting, which will be called by the chairman, the organization and program of work may be completed and questions formulated on which it is desired to have preliminary discussions by the society. For the preliminary report requested for Nov. 1, 1918, the committee can hardly expect to do much more than record a program of work, propose questions on which the views of the membership are desired, and submit topics for discussion. Before the time of another meeting, which possibly may well be held at about the time of the annual meeting of the society in January next, progress in the work will have been made, and it may be expected that much will be accomplished at this second meeting.

In its work the committee will doubtless make a study of the engineering society organizations of this and other countries and of professional and scientific organizations of various kinds. Information concerning the society and its work may be obtained from the secretary of the society.

The method adopted for selecting the committee gives a wide geographical distribution and an opportunity for the representation of local views. It has the advantages of giving a channel by which discussions of the problems at meetings of the local associations of members may reach the committee, and it is hoped that the local associations will be helpful in the work. It will be borne in mind, of course, that the committee is a committee of the whole society, and it is expected that it will give careful and impartial attention to the interests of every part of the society. The method of selection used should not be taken to mean that members of the committee are delegates of the local associations of members; and it also may be noted that the three geographical districts of the society which do not have local associations of members have much less than a proportionate representation on the committee. Necessarily proposals for new activities and for modification of old ones must take into consideration the financial resources of the society, and the financial side of all questions of course will receive the careful attention of the committee. The questions before the committee are the broad questions of policy, and personality will not enter into their discussion. With a variety of points of view and with the opportunity for widespread consideration of the proposals of the committee, it may be confidently expected that the final report of the committee will receive substantial approval from the society.

The committee has a great opportunity to be of service to the American Society of Civil Engineers and its membership. It is hoped and believed that the work of the committee will have significant and far-reaching results in the development of the society and the usefulness of the profession of engineering.

## Aerial Cableways Handle Plates at Shipyards

Aerial tramways, states the Emergency Fleet News, are being used for handling plates and other ship material by several shipyards on the Pacific Coast. The system is an adaptation of the aerial tramway systems in common use in mining and quarry work. In the Pacific Coast Shipbuilding Co. yard, the masts are 110 ft. high from the ground surface, and a sag of 22 ft. is permitted in the center of the cableway. Each slip has two of these aerials, parallel to and immediately over the side of the ship. There are two hoists or hooks to a ship, and in handling heavy material both hooks can be joined, the capacity thus being doubled. It also is possible to swing the material into any part of the ship beyond the line of the perpendicular of the aerial. There is a single anchorage for both materials of each slip at the head and at the water side. This is a concrete block 19 ft. square and 9 ft. deep, buried in the earth. In this are embedded solid 2-in. rods, to which the 1¾-in. wire cables are fastened, provision being made for taking up the stretch in the line by U-bolts. The outboard anchorages are formed of a cluster of a dozen piles driven to refusal and later blocked solidly, peace-piled and bolter together. The wire cable is wrapped securely around this dolphin. At the feet of the inshore masts are placed the hoisting engines, operated by electricity. The cables run vertically to the heads of the inshore masts through sheaves at this point, and hoisting and cable travel is entirely controlled from here. Material is picked up from in front of the plate shop, where the fitting-out space is situated, and carried to the way without rehandling.

**Seventy-four Ships from American Yards in September.**—American shipyards launched 45 steel ships and 29 wooden ships during September. The total deadweight tonnage was 362,000, as compared with 339,000 in August.

# Method of Building Concrete Barges at Yard of Aberthaw Construction Co.

The Aberthaw Construction Co. of Boston, Mass., which recently established a shipyard at Fields Point, R. I., is now engaged in the construction of 500-ton concrete lighters.

The system employed at this yard, which differs in some ways from what has hitherto been common practice, requires the use of an extremely high-grade Lehigh Portland cement ground so that 90 per cent will pass a No. 200 sieve. The sand is either broken or clean bank gravel, well washed and graded ranging in size from ⅛ to ½ in., while the aggregate is of such a size that it will pass a ⅝-in. ring. Great care is taken in the selection and grading of the aggregates, the maintenance of a rich mixture, the avoiding of an excess of water, and, perhaps, what is of the most importance, all batches are mixed for not less than 2 minutes after all the material is in the mixer. In mixing, the stone and a portion of the water is placed in the mixer first which is turned over sufficiently to scour the sand clean; the remainder of the aggregate, cement and water then being added. In order to obtain best results it has been found that the amount of water required is 9 per cent by weight of the cement and aggregates.

The concrete is mixed in a motor-driven 4-bag Ransome mixer with side loader for charging and is spouted from the tower hopper by means of a short section of chute to a distributing point to buggies or wheelbarrows at the end of the boat at deck level. From this point it is wheeled along staging at deck level to points where the placing gang is working, whence it runs through a short chute to a mortar box at the level of the placing gang and is shoveled into place in the forms. In no case is the concrete poured through a height of wall more than 3 ft.

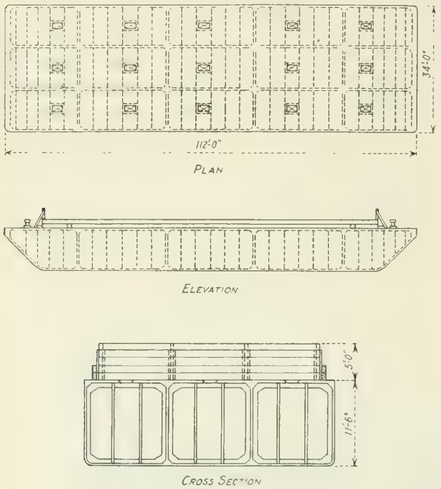
Concreting proceeds continuously from the point at which it starts working constantly around the edges of material already deposited so that in no case does any section of concrete stand, whether in the wall or floor, for more than ½ hour before continuing to concrete. When a definite joint is provided Aberthaw practice requires the surface to be carefully picked to remove all laitance, washed thoroughly clean and painted with a coat of grout made of neat cement and water mixed to the consistency of cream. Care is taken that the concreting proceeds before the grout gets its initial set.

The forms are made up in panels, every precaution being taken to insure a smooth, true, impervious surface on the outside, the exact dimensions given being rigidly adhered to as the small sections and high stresses used might be productive of serious results in the event of any deviation from the required concrete sizes. The panels are surfaced with a covering of galvanized iron, the metal sheets being butt-pointed and tacked in position with the metal stopping exactly at the edges of the panel. Both inside and outside panels or forms are made of sound air-dried lumber with extra cleating to prevent warping and twisting and to provide a smooth tight surface. The surface of all exposed woodwork is painted with one coat of boiled linseed oil as soon as the panels are made up, in order to make them as impervious to weather conditions as possible.

Aberthaw Shipyard at Fields Point, R. I.

The erection of forms proceeds as follows: Starting with the sleepers 8 in. or 12 in. x 6 in. firmly tamped into place and providing a bearing value of four tons per square foot the posts and girts are erected, carefully trued and leveled. These are followed by the joists, floor panels and wall panels in the order named, the wall panels being strongly braced so that they will maintain a position exactly corresponding to the outline intended for the boat. The next step is to place in proper position the bolts, wooden washers and the C. I. spacers ready to receive the reinforcing steel, after which the curved wooden fillet at the outside bilge curve is placed. The inside supporting floor forms and the floor beams sides are erected next, followed by the placing of the inside face of walls, bulkhead walls and pilasters. Throughout the erection of the forms a variation from level of more than ¼ in. is not allowed.

All of the steel used for reinforcing is of mild structural grade, that used for the longitudinal girders being in one continuous length, butt-welded where necessary, care being taken that the welds are staggered, so that no two welds are within 40 in. of each other. The bars for the transverse frames are made continuous in like manner. All intersections of bars are fastened with soft annealed wire wrapped around them and tightly twisted. No steel is placed nearer to the surface than one inch.



**Plan, Elevation and Cross Section of 500-Ton Concrete Lighter.**

The outside shell and deck are 3 in. thick and are reinforced with round deformed bars of the Corrugated or Havemeyer type. The bottom slab and frame are designed to carry an upward pressure of water equal to a head of 11 ft. 6 in. and the side walls and frames are designed on the assumption that the water might be flush with the deck. The sides and the bottom are painted on the outside for greater impermeability, the bottom on the inside being flowed level with a rich mixture. The decks are granolithic finish.

**Interior View of Concrete Barge.**

The time required for the setting of wall panels is a trifle over a week, the floor and deck panels requiring not less than two weeks after the concrete is poured. Each barge requires 500 bbl. of cement, 75 cu. yd. of sand and 130 cu. yd. of ½-in. stone, together with approximately 44 tons of reinforcing rods ranging in size from ⅜-in. to 1⅛-in.

The lighters now under construction are 112 ft. over all, with 34-ft. beam and 11 ft. 6 in. in depth. The draft empty is 3 ft. 9 in. and fully loaded 9 ft.

The general shape of the barge is that of a rectangular box with the bottom sloping upward at each end and the corner formed by the junction of the sides and bottom rounded off to a 6-in. radius. Four transverse and two longitudinal bulkheads divide the lighter into fifteen watertight compartments of approximately equal cubical capacity.

The deck of the lighter, which is without camber, is designed for carrying coal or a similar cargo and is constructed to take a uniformly distributed live load of 500 lb. per square foot, while the compartments themselves are well adapted for handling fuel oil. Each of the fifteen compartments is fitted with a hatch set in an iron frame furnished with rubber gasket and suitable provision for battening down. To assist in holding the deck load a timber bulkhead is built enclosing an area 90 ft. by 30 ft. The side bulkheads are 2 ft. high and end walls 5 ft. in height.

The barges are fitted with cast iron chocks, cleats and bollards; the majority of the balance of the hardware used being galvanized. Bitts and fenders are of oak, the remainder of the woodwork being hard or long-leaf yellow pine, dressed on four sides.

# New Lathe Will Handle Masts 100 Ft. in Length

The Traylor Shipbuilding Corporation, Cornwells Heights, Pa., has in operation in its yard a mast turning lathe that is one of the new developments in shipbuilding since the Emergency Fleet Corporation was created. Formerly the making of masts was a long and laborious operation fit for the best work of especially skilled men. The machine, according to the Emergency Fleet News, will handle timbers for a mast up to 100 ft. long and 3 ft. in diameter. The timber, after being centered and set up in the machine, which usually requires about half a day, is revolved at a speed of 50 revolutions per minute, by means of an electric motor, thus coming in contact with the cutter head, which is mounted on a carriage attached to the motor, and set at right angles to the mast. The cutter head revolves at a speed of 700 revolutions per minute. In this head are three hooked knives, which cut the material from the mast.

The carriage is propelled by a wire rope on a gypsy head, which also is run by a motor, the feed of the carriage being practically the same as on an old-fashioned saw-mill.

When a mast is extra long and sags in the middle, it is necessary to put a steady rest at the point where the sag is greatest, thereby making the timber run true. To get the shape of the mast; that is, the taper at the top, it is necessary to set a rail which is bolted down to the bed of the machine and bent in exact position as the profits of the mast which is to be cut. On this rail runs a shoe, controlling the cross movement of the carriage. If the rail is set away from the machine, it pulls the carriage closer to the center of the mast. If it is set nearer it moves the carriage further away. The machine is very simple in operation, requiring the attention of only one man at the cutter head and another as a helper to assist in making adjustments.

## 4,000 Ton Wood Ship Built in 17½ Days

The Grays Harbor Motor Ship Corporation of Aberdeen, Wash., on Sept. 28 launched a 4,000 deadweight ton wood ship that had been built in 17½ working days. The ship was delivered to the U. S. Shipping Board and accepted for service on Oct. 6, 24 working days after the hull was placed. The keel was placed on Sept. 9 and the steamer entered the water with hull and superstructure 95.7 per cent complete and engine installation 40 per cent complete. The boat is a twin screw steamer, 290 ft. over all, 49-ft. beam, with a molded depth of 28.2 ft. It was designed by M. R. Ward, plant manager, and adopted by the U. S. Shipping Board. The boat has triple expansion, inverted cylinder type engines designed to give a load speed of 10 knots per hour.

# The Objects of Structural Engineering Courses*

By HENRY I. BURT.

Structural Engineer, [illegible]

In this land where education is a public function the welfare of the commonwealth has first claim to consideration in the objects to be attained. The selfish interests of the student must be subordinate. If success be considered works accomplished rather than financial gain, the interest of the state and the interest of the student may be considered identical. The man should be trained to be a constructor, rather than a contractor; to be an economist of materials and labor rather than an economist of money; to conserve or make useful material resources rather than to consume them. These consideration are very general, but should be in mind while specifying the training to be given in structural engineering.

Structural engineering is here considered as a part of the broad profession of civil engineering. Although its importance is growing rapidly in relation to the other branches of civil engineering, it has not yet become recognized as a distinct and separate profession. It follows that the structural courses must be a part of any complete curriculum of civil engineering. So far as the writer is informed, it is so recognized in all engineering colleges.

A broad definition of structural engineering makes it include all static structures whose designs are based on scientific principles and mathematical calculations. It involves the relation of load to strength, or stress to strain. There is practically no engineering design that does not involve the principles and calculations of structural engineering. This being so, it is evident that structural engineershould form an important part in the study of civil engineering.

The proportion of the time which should be devoted to this subject is not easy to determine. Perhaps the minimum that should be considered is that required for the study of mechanics of materials, physical properties of materials, and static stresses. At the other extreme would be the time required in curricula when electives are allowed and the student chooses subjects in structural design as his major courses.

The purpose of most students in engineering is to prepare for the practice of the profession as a means of livelihood. If left to their own guidance, they would likely select the subjects that promise the earliest results, i. e., get them into remunerative employment at the earliest practicable date. This would lead to the study of the practice of engineering rather than the science on which that practice is based. In a few years the man would find that he was practicing the art of engineering rather than the science; that he had become an artisan rather than a professional engineer.

Such a result as described above does not represent the best development of the student, so he must be guided into a better channel. He is entitled to such training that he can secure employment in engineerig work, but he is not entitled, nor is it to his interest, to be so trained that he can secure an advanced position in practical work, but be lacking in the foundations from which he can build a professional rather than a craftsman's career.

In spite of good resolutions made at the time of graduation, this natural tendency is to neglect scientific studies. Very few young engineers after graduation give any time to advancing their knowledge of the theory of engineering except when forced to do so by the problems confronting them. The less they know of scientific principles, the less likely they are to pursue the study of them after leaving school.

Recognizing the inability of the student to be his own guide during college days, and recognizing his tendency to neglect scientific study after graduation, it devolves on the teachers not only to prescribe the studies to be pursued during the college period, but to so train the student that he will continue in a progressive channel—all this to the end of securing the best ultimate result rather than early but limited success.

The foregoing discussion indicates the desired preponderance of training in the science of design. The purpose of this training is twofold: (a) To store in the brain the fundamental principles involved so that they will always be ready for reference. This should be done as thoroughly as the implanting of numbers and letters is done in childhood. (b) To develop in the mind the powers of analysis, synthesis, observation, imagination and logic, so that the man will always be a student.

Some work in the art of design is necessary to illustrate the principles involved. It should be done more with this purpose than for the purpose of training a craftsman. The latter feature cannot be wholly disregarded for the man must be equipped with enough practical skill to make him useful and enable him to start in the practice of his profession. But he must depend on his experience after leaving college to assemble in his storehouse the information, and to acquire by practice the skill that will ultimately make him a success in his profession.

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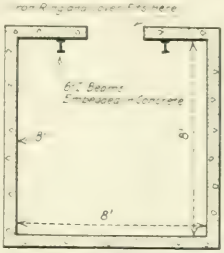
*From Bulletin Society for Promotion of Engineering Education.

# Cost of Concrete Vault for Electric Cable System

By H. R. FERRISS.

The following costs cover the labor and material used in the construction of a concrete vault (manhole) several of which were built in connection with an electric street lighting system. The record was carefully kept and as the design is standard in several cities in the United States, the information may be useful for purposes of comparison.

The work was done in 1911 and the rates were those prevailing in the Pacific Coast city at that time. They are interesting in comparison with the rates prevailing at the present time for similar work:



Concrete Vault for Electric Cables.

LABOR

| Classification. | Hours. | Rate, ct. | Cost | Unit cost per cu. yd. |
|---|---|---|---|---|
| Excav. and back-fill for sewer drain | 64 | 32 | [illegible] | [illegible] |
| Excavation for vault [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Team, remove excess earth [illegible] | [illegible] | [illegible] | 7.50 | .30 earth |
| Back-fill including puddling, etc. | [illegible] | [illegible] | 6.40 | 1.00 earth |
| Erecting and removing forms | [illegible] | [illegible] | 13.00 | |
| Place reinforcement, etc. | [illegible] | [illegible] | 2.00 | 2.25 concrete |
| Mix and place concrete | [illegible] | [illegible] | [illegible] | |
| Finishing walls, etc. | [illegible] | 62½ | 3.75 | |
| Build barricades, watchman, etc. | 7 | 30 | 2.10 | |
| [illegible] charge for [illegible] and over-head (estimated) | | — | 10.00 | |
| Total | | | $112.20 | |

MATERIALS

| | Rate | Cost |
|---|---|---|
| Cement, 32 bbl. | [illegible] | [illegible] |
| Sand, [illegible] | [illegible] | [illegible] |
| Gravel, [illegible] | [illegible] | [illegible] |
| Lumber (charge one-fourth), 720 ft. B. M. | 13.00 | 2.35 |
| [illegible] sewer pipe [illegible] | [illegible] | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | | [illegible] |
| | | [illegible] |

*Hauled one-third mile in dump wagon.

All excavation was in stiff, white clay—no water. The vault was 8 ft. square and 8½ ft. deep. Costs of materials include delivery The concrete was in 1:3:5 mix. Wire mesh reinforcement was used in the walls, floor and roof.

**South Africa Proposes Erection of Grain Elevators.**—The Government of the Union of South Africa proposes to adopt the elevator system for handling grain and has invited applications from consulting engineers experienced in work of this kind. The man selected will be required to visit South Africa to advise the government. Applications, stating terms, etc., should be sent to the High Commissioner for the Union of South Africa, 32 Victoria St., London, S. W., England.

## Cableway with Equalizing Girder Transports Material for Erection of Kettle Rapids Bridge

A cableway provided with a triangular equalizing girder gave excellent service in transporting materials and in erection of steelwork for the Kettle Rapids Bridge of the Hudson Bay Ry. This bridge is a continuous structure 1,000 ft. long, consisting of a 400-ft. channel span and two side spans each of 300 ft. The trusses or main girders are of the sub-divided Warren type, 50 ft. deep throughout, 24 ft. apart center to center, having 25-ft. panels.

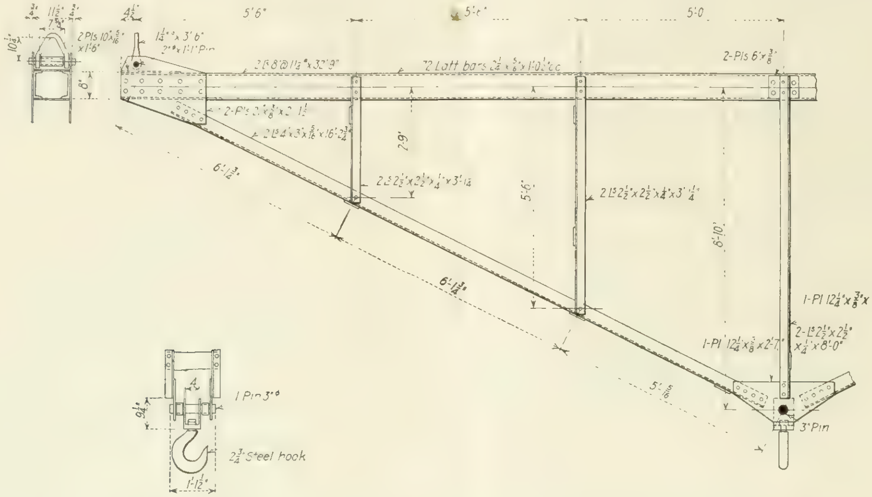

3/4"
11 1/2"
3/4"
7 3/4"
10 1/4"
2 Pls 10"x5/16" x1'-6"
4 1/2"
1 1/4"x 3' 6"
2"x 1'-1" Pin
8"
5'6"
5'-6"
5'-0
2 [s 8" @ 11 1/4# x 32' 9"
72 Latt bars 2 1/4" x 5/16" x 1'-0 1/2" cc
2-Pls 6"x 3/8"
2-Pl's 2"x 3/8" x 2' 1 1/2"
2 Ls 4"x3"x 5/16"x 16'-2 3/4"
2-9'
6'-1 3/4"
2 Ls 2 1/2"x 2 1/2"x 1/4"x 3'-1 1/4
5'-6"
2 Ls 2 1/2"x 2 1/2"x 1/4"x 3'-1/4"
6'-1 3/4"
8'-10"
1-Pl 12 1/4"x 3/8"x
2-Ls 2 1/2"x 2 1/2" x 1/4"x 8'-0"
1-Pl 12 1/4"x 3/8"x 2'-7"
5'-5/16
3" Pin
9 1/4"
A
1 Pin 3"
2 3/4" Steel hook
1'-1/2"

Fig. 1—Details of Equalizing Girder Used on Cableways in Erection of Kettle Rapids Bridge.

The double cableway was erected primarily for transporting to the opposite side of the river the materials for the northern half of the bridge. The cables were supported on a rocker bent 40 ft. high, standing on the top chords of the southern cantilever, and on a timber tower 120 ft. high from the ground surface, located behind the north abutment.

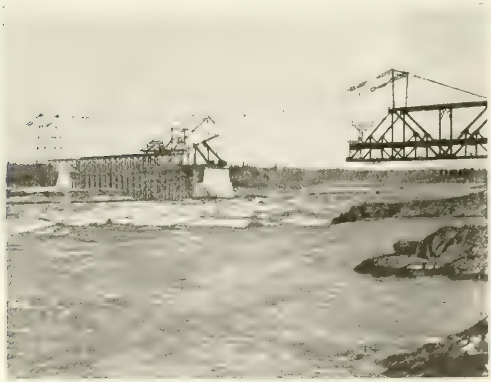


Fig. 2—View Showing Cableway with Its Equalizing Girder.

The span of the cableway was 611 ft.; the sag under maximum load 36 ft.; and the horizontal distance of the anchorages, at both ends, from adjacent support, 400 ft. A triangular equalizing girder, suspended at its ends from the cables and having a lift hook at the center, was provided for loading cables equally. Details of this equalizer are shown in Fig. 1. The cableway was designed for a live load of 14 tons, the weight of the heaviest pieces to be transported. The Kettle Rapids Bridge was designed by Mr. W. Chase Thomson, Consulting Engineer, Montreal, Que. The superstructure was fabricated and erected by the Canadian Bridge Co., Ltd.

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## Accidents in Building Industry

Statistics of the Industrial Board of Illinois show that the number of compensatable accidents in building work in 1915 was the second highest of all industries; in fatal accidents it tied for first place; in the cost of fatal accidents it was first by quite a margin; in the cost of nonfatal accidents it was not far from the highest and nearly twice the cost of the third cause. It was the highest in the average days' disability with 27.3 days per case. The total days' disability was 68,436. Sixty per cent of the nonfatal accidents and 85 per cent of the fatal accidents were due to falls, falling objects and handling materials—causes which in themselves should not be hazardous. The percentage of compensatable accidents, due to machinery and equipment, was slightly less than 6 per cent. This does not include accidents due to hand tools, which ran 5.6 per cent. The accidents in the latter cases, however, are largely due to injuries self-inflicted or by fellow workmen and not to inherent defects in the tools or lack of proper safeguards.

One hundred and forty-eight accidents due to machinery and equipment resulted in disability of 4,740 days. The average length of disability for each individual was 32 days, the second highest average of accidents from any source. The average cost per accident of all sources was $77, whereas the average cost of machinery and equipment accidents was $116 higher than the average cost from any other source.

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**New Swedish Company to Build Concrete Ships.**—A Swedish company—Aktiebolaget Svenska Betongverken (Swedish Concrete Co., Ltd.)—is being organized in Stockholm to deal in concrete moldings and ship construction, but its main object is the construction of concrete ships. Contracts have already been made with a firm for the delivery of the necessary machinery. Twenty ships per year is the calculated maximum construction of the yard, and the first ship will be launched in about six months. According to the Stockholm press the new company's capitalization is fixed at $536,000 minimum and $1,608,000 maximum.

# Review of Stucco Tests of Bureau of Standards*

By J. C. PEARSON,

U. S. Bureau of Standards, Washington, D. C.

The first stucco tests were started in 1911, and consisted of small panels of metal lath, the majority of which were covered with cement and lime stucco in the approximate proportions of ⅔ part cement, 3 parts sand, and ⅓ part hydrated lime, by volume. These panels were erected primarily for the purpose of determining the effectiveness of various treatments or protective coatings of the metal itself in preventing corrosion. These tests (which are still in progress) have demonstrated conclusively that galvanizing is the most effective treatment of metal lath for its preservation, and that a coating of asphalt or "dip" offers a sufficient degree of protection to the metal to ensure its satisfactory durability under average exposure conditions. Many of the painted or dipped lath panels are still in excellent condition after nearly seven years' exposure, notwithstanding the fact that the metal is exposed on the inside and the construction not entirely weatherproof. Perhaps the most important lesson from these original tests, especially in view of later experience, was that corrosion of metal lath is one of the minor obstacles to the development of a successful stucco.

The tests made in 1915 were carried out on a large scale under conditions that similate actual construction. The test panels were large enough to contain window or door openings, and to allow the plasterer the same freedom of action that he would have on a regular wall. Regardless of the distribution of stuccos, the concrete panels as a group have the highest rating, the plaster board panels the lowest. In these tests, the back-plastered metal lath panels probably take second place, and the gypsum block panels are near the bottom of the list.

**Method of Finishing Cause of Cracking.**—There were certain outstanding facts which furnished suggestions for future work. In the first place there was evidence that the prevalence of craze and map cracking on most of the 1915 panels was due to the method of finishing. It has been specified that a sand float finish should be used, and that this finish should be given in the shortest possible time after laying on the finish coat. The purpose of this was to avoid disturbing the so-called initial set of the cement. In consequence the very great majority of the panels were floated when too soft, which resulted in bringing to the surface a rich mixture of cement or cement and lime, subject to high shrinkage upon drying out. We believe now that this accounted largely for the general and early appearance of fine cracks on most of the panels, with some contribution also from the use of too rich mixtures.

**Cracks Resulting from Shrinkage of Sheathing.**—Another peculiarity that impressed itself upon us was the appearance of large and prominent cracks on all the panels over diagonal sheathing. These cracks invariably first appeared off the corners of the windows and running across the direction of the sheathing, and there is no question that they were brought into prominence, if not actually produced, by the shrinkage of the sheathing. The fact that these characteristic cracks did not appear on the back-plastered panels, and that the latter were largely free from prominent cracks, resulted in a higher rating for this group than for the metal lath panels over sheathing.

**Weak Base Common Cause of Stucco Failure.**—One other consistent development in these 1915 panels is of special importance, viz: It was noted that the stuccos on the plaster board and gypsum block panels and on the monolithic concrete panel coated with bituminous waterproofing were in poor condition, especially after they had passed through the second winter. All of these were stuccoed with the standard mixture of 1 part cement, 1/10 part hydrated lime and 3 parts sand, with only slight modifications in the method of applying. The results obtained on these panels indicate, not that this stucco is bad, but that the combination of this stucco and a weak base is bad. Field observations which I had an opportunity to make last year demonstrated this fact conclusively, that a strong cement stucco on a weak base is a common cause of stucco failure, and in practice this seems to occur most frequently in the application of brown and finish coats much higher in cement than the scratch coat, which logically should be the strongest portion of the stucco. The explanation of this failure must be sought in the well-known shrinkage of cement mortar upon drying out, and in the subsequent movements caused chiefly by varying moisture conditions.

**The 1916 Tests.**—In laying out the program for the second year's work it was found most feasible to erect a sort of monitor or penthouse, providing 22 additional panels, on the roof of the original building. This, of course, precluded all but frame construction. The back-plastered panels had shown up so well in 1915 that it was decided to include a larger proportion of these in the new layout, and only one-half the monitor or annex, as it is more commonly called, was sheathed. To minimize the shrinkage effects 6-in. diagonal sheathing was used, alternating in direction on adjacent panels. It was decided also to change the method of finishing, partly in the use of less water on the under coats, and partly in waiting for the stiffening of the finish coat to develop before finally floating. This procedure, together with the use of a number of leaner mixtures, was adopted in the hope that craze and map cracks would be largely overcome. A number of special features were also included in the construction of certain panels with a view to minimizing the effects of movement of the wood frame.

**Deductions from 1916 Tests.**—The deductions from the 1916 tests may be summarized as follows:

1. Diagonal sheathing of unseasoned wood is apparently an unsatisfactory backing for stucco. With only unseasoned wood available horizontal sheathing would appear to better construction, provided sufficient bracing of the wood frame is assured.
2. Back-plastered construction appears to be best for frame structures, so far as the integrity of the stucco is concerned. This carries with it, however, a need for fuller information regarding the insulating qualities of walls so constructed.
3. Lean mixtures promise better cement stuccos, provided the necessary plasticity and density can be maintained by proper grading of the aggregate.
4. There is still need of further information as to the value of wood lath and high lime stuccos. To date the tests indicate that wood lath is not as satisfactory as metal lath, and there is no conclusive evidence that a modern hydrated lime stucco will endure satisfactorily in severe climates.

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**Ship Ends Trial Run 8 Days After Launch.**—A record for speedy completion of a vessel after launching has been made by the Fore River plant of the Bethlehem Shipbuilding Corporation, Quincy, Mass. The steamer "W. L. Steel," 9,100 deadweight tons, was launched Sept. 2 and had finished its trial run and was ready for delivery on Sept 10. The actual time that elapsed between the launching of the vessel and the completion of her successful trial run was 8 days and 9¾ hours, beating by nearly two days the best previous record reported, that of the "Tuckahoe," built by the New York Shipbuilding Corporation and completed within 10 days after launching.

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**Ship Riveters on Piece Work Making $100 Weekly.**—Riveters at the plant of the Submarine Boat Corporation, according to Speed Up, the official publication of the yard, are commonly earning around $100 a week. In three days recently one of the star riveters drove 2,375 flush rivets in a shell, earning $172.69 for the gang, of which he received $75.59. On one Sunday, another crew drove enough rivets to earn $101. Still others earned, respectively, $87, $72.52, $70.84, $65.68 and $64.44. Piece work in reaming was started at the Submarine Boat Plant recently. Under this system one man has reamed 1,328 holes, earning $23.24 for a day's work. The average pay of the reamer ranges from $14 to $24, which brings them practically up to the level of the riveter.

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*Abstract of paper presented at [illegible] annual meeting of American Concrete Institute.

# Proposed Constitution for New National Association of General Contractors

A call has been issued to general contractors to attend a convention to be held at Chicago, Nov. 20-21, to form a permanent national organization to be known as the National Association of General Contractors. The temporary executive committee of contractors formed last July at the Atlantic City Convention of the Building Industries has drawn up a proposed constitution which will be submitted to the Chicago convention. Extracts from this constitution follow:

**Purposes.**—The objects of the association are to promote better relations between private owners and public bodies and their architects and engineers on the one hand, and contractors on the other; to maintain high standards in the conduct of construction work; to combat unfair practices; to encourage efficiency among contractors, to support contractors and contractors' associations in efforts to rectify construction conditions of an unsatisfactory character; to encourage those methods of contracting for work which relieve the contractor of improper risks, and to encourage sound business methods tending to raise the standing of contractors generally in the business world.

**War Service.**—1. The association shall endeavor to focus on the construction problems raised by the war the resources of contractors, and to co-operate with the Government to distribute work required in the best manner.

2. The association will also endeavor to collect facts regarding non-war construction work which will show whether materials and labor can be obtained without affecting the war program.

**Membership.**—1. Members of the association shall be national, state or local organizations of general contractors, or individual firms engaged in general contracting where there does not exist an available association eligible to membership. Members of associations must be general contractors in order that said associations may be eligible to membership in this association.

2. The terms "general contractor" is understood to mean a contractor or contracting firm engaged in construction work which undertakes and carries out, at least partly with its own forces, construction operations of any description in their entirety.

**Administration.**—1. All affairs and activities of the association shall be conducted by an executive board of 15 elective members and of the three elective officers of the association, who shall be a president, a vice president and a treasurer.

2. The executive board shall hold two regular meetings each year, at times and places to be determined by it. At these meetings all regular business of the association shall be considered.

3. Special meetings may be called by any two of the elective officers of the association.

4. The president of the association, or, in his absence, the vice president, shall preside at sessions of the executive board.

5. The president and executive board shall employ a paid secretary, who shall have a close acquaintance with the contracting business. The secretary shall conduct the general offices of the association, which shall be located in Washington during the remainder of the war. He shall be empowered to employ the necessary office staff and to conduct the business and further the objects of the association. His compensation and the expenses to be incurred in maintaining the offices shall be determined by the executive board.

**Dues.**—The dues of the association shall be for each individual member firm $50 annually and for member associations, $10 annually for each member of such member association at the beginning of the year in which the dues are paid, with a minimum for each association of $100 per year.

# 89 Year Old Masonry Viaduct Still in Service on B. & O. R. R.

Two masonry bridges, each over 80 years old, are still in service on the Baltimore & Ohio R. R. The following description of these structures is taken from a committee report presented at the recent convention of the American Railway Bridge and Building Association:

The oldest of these bridges is a double track viaduct having a total length of 297 ft., in the center of which is an 80-ft. semi-circular arch, spanning Gwynns Falls near Mt. Clare Junction, Baltimore, Md. It was erected by James Lloyd in 1829 of native granite cut to a true surface and laid in lime mortar. The retaining or wing walls forming the approaches to the arch are reinforced at intervals of 25 ft. by massive battered pilasters extending the full height of the structure, the top of which is 65.5 ft. above the bed of the stream.

Instead of filling the space above the arch and between the parapets as is the present day custom, longitudinal brick walls 12 in. thick and spaced 3 ft. center to center, with cross walls of similar construction located at 5 ft. intervals were constructed on the haunches and over the arch, upon which were placed granite slabs 12 in. thick, to form the subgrade of the roadbed. The parapets or side walls originally extended to a height of about 4 ft. above the track grade.

As new ballast was placed from time to time, the track grade was gradually raised, until at the present time, it approximates the grade of the top of the parapets. This and the increased weight of rolling stock, produced a greater thrust against the parapets than they were designed to stand. It was therefore necessary to take down and rebuild the wall on one side about 2 years ago and the other is now being treated in a similar manner. To prevent a recurrence of the trouble experienced in the past, these walls are being reset with concrete backing extending well back under the tracks to take the thrust from the walls proper. In resetting the face stones special care is taken to place them in their former positions to preserve as far as possible the original character of the structure. Outside of this work, and sealing with concrete the foundation under the west abutment of the arch, which had been exposed by erosion, no repairs have heretofore been made and the balance of the structure, after about 89 years of service, is in an excellent state of preservation. Had the original grade been maintained, it is probable that no repairs to the superstructure would have been necessary for many years to come.

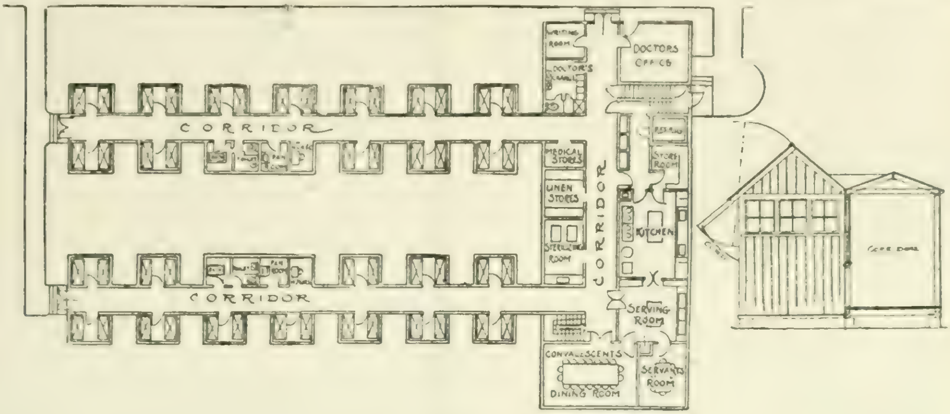
The second bridge is known as the Thomas viaduct. It crosses the Patapsco river at Relay, Md., about 8 miles west of Baltimore. It is a double track bridge consisting of a series of eight semicircular arches, each having a span of 58 ft. at the spring line, the total length of the structure being 612 ft. with a height of 59 ft. above the bed of the river. It was built of native granite in 1833 to 1835.

The subgrade or roadbed of this structure was also formed by the construction of brick longitudinal and cross walls supporting granite slabs as described for the viaduct over Gwynns Falls. The feature of special interest in this structure, however, is the fact that it is located upon a 4° curve. With the exception of resetting the parapet walls several years ago, which failed for the same reason given in the case of the Gwynns Falls viaduct, no repairs have been necessary, and the balance of the structure is apparently in as good condition as when first built, after about 83 years of service.

The general designs of the two structures were very much the same, except that in the Gwynns Falls viaduct the exposed surfaces of all masonry were dressed to a fairly smooth surface, with panels introduced in the large blank spaces between the pilasters and above the arch ring, while all exposed surfaces of the Thomas viaduct except the inner surfaces of the ring stones were left with rock face finish.

# Spanish Influenza Hospital That Can Be Erected in 6 Days

A special type of structure, developed from the tent hospital idea, is being employed by the U. S. Shipping Board for housing influenza patients from the board's Atlantic training base at Boston, Mass. The medical authorities of Massachusetts also have adopted the Shipping Board hospital idea and propose the erection of a group of the hospitals to be paid for out of a fund of $100,000 appropriated by the state to check the influenza epidemic among the civilian population.



Ground Plan of Influenza Hospital and Side Elevation of Cubicle.

In the Shipping Board hospital the patients are housed in specially built shacks in which ventilation can be controlled and a maximum of sunshine secured. In each shack one-half the roof can be tilted back, opening up the rooms to the sun and air. One side of the room is a glass sash that can be opened out completely. The walls of the rooms do not reach to the roof, leaving about 1 ft. clearance for air space. In each room there are two beds, with a sterilized sheet hung between to prevent the passage of germs. The cubicle is connected by a door in its back wall with a heated corridor, which connects with an administration building.

It is stated that a large hospital can be built on this system in 5 or 6 days. The plan for these hospitals was developed by Dr. William A. Brooks, Medical Director of the Shipping Board Training Service, Boston.

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**Rapid Rivet Driving.**—According to Speed Up, a publication of the Submarine Boat Corporation, 57 gangs at the Newark Bay yard on Sunday, Sept. 15, drove a total of 27,820 rivets in 8 hours, an average per gang of 488. The gang average per hour was 61.

The detailed report of the day's work follows:

| No. gangs | Total rivets driven. | Average per gang. | Total hours. | Av. per gang per hour. |
|---|---|---|---|---|
| [illegible] | [illegible] | 472 | 8 | [illegible] |
| [illegible] | [illegible] | [illegible] | 8 | 41 |
| 13 | [illegible] | [illegible] | 8 | 46 |
| 10 | [illegible] | [illegible] | 8 | [illegible] |
| 11 | [illegible] | 416 | 8 | [illegible] |
| [illegible] | [illegible] | 520 | 8 | [illegible] |
| [illegible] | 1,283 | 428 | 8 | [illegible] |

A crew at the yards of the Downey Shipbuilding Corporation at Arlington, N. Y., recently drove 1,632 ⅞-in. countersunk heavy shell rivets in 8 hours.

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**Planking Record at Tacoma Yard.**—A planking crew of 11 men at the shipyards of Foundation Co. at Tacoma, Wash., recently put on 11 garboard planks in one day. The planks equaled 748 ft. of timber.

# Salvage Department at Shipyard a Money Saver

A salvage department established by the Pusey & Jones Co. at the Gloucester, N. J., shipyard in one week showed a net profit of $5,805 from sales of steel scrap, general junk and other waste. The work of the new department is described in The Annalist, from which the following notes are taken:

The Department consists of a foreman, assistant foreman, a clerk and 20 laborers, who are engaged in the outside yard work of the department. Five acres of land outside of the main shipbuilding yards have been allotted to the Salvage Department for its work. Whenever a superintendent or head of any department finds a congestion of waste and scrap material, he calls up the Salvage Department, and it immediately sends a gang out to gather up all this refuse and take it to the salvage yard. Here there is one man, a junk expert, who knows exactly how to sort out the material for sale. Of the five bins which have been erected, 20 ft. from the ground, one is used for punch balls, one for borings and turnings, one for plate scrap, another for miscellaneous scrap, and another for miscellaneous waste material. These bins are so arranged that by opening the door the scrap iron will automatically slide or can be pushed into cars on the railroad track below.

As most of the material which the Salvage Department gathers up would have been utter waste had this department not been organized, it has been provided that all stock which is sent back to any department to be used over again, or which any department requisitions, is to be credited to the account of the Salvage Department. In this way much time is saved, owing to the fact that representatives of departments such as the yard and electrical departments can often come to the salvage yard and find articles that they will need, and thus save the time and trouble of ordering it from an outside source.

By means of a grasshopper crane, all the steel scraps are gathered from the yards and carried out to the Salvage Department. These scraps average three carloads of steel a week of about 40 tons each. Through the Waste Journal, a paper giving market prices on all scrap, the foreman of this department is able to keep posted as to where he will be able to get the best prices. Previous to the organization of the salvage work there had been from time to time some few sales of scrap steel by the various departments; but this was on a small and haphazard scale.

Two of the 20 laborers in the Salvage Department are paper pickers, who go about the yards and gather up all scraps of paper. Each yard also has its own picker, who co-operates in this work. In a room of the basement in one of the office buildings bags have been placed, and the janitors from all other departments are instructed to carry all waste material and paper to this central station, where it is later transferred to the Salvage Department. All the waste paper which is turned in is baled and sold by carload lot. The revenue derived from this source is just about enough to pay for the cost of picking it up, and thus the yards are kept clean without any extra cost to the company.

## Expansion Bearings of 1,000 Ft. Continuous Girder Kettle Rapids Bridge

The recently completed Hudson Bay Ry. bridge over the Nelson River at Kettle Rapids is provided with rocker bearings, having 8-in. bearing pins at the piers and 6-in. bearing pins at the abutments. The shoes are steel castings. The bridge is fixed at Pier 3 and movable at Pier 2 as well as at the abutment. At Pier 2, the expansion rollers are 8 in. in diameter and each set is provided with four 12-tooth cut pinions to prevent skewing. Substantial curtain plates are provided for the protection of the gears and to keep out the dust. These plates are removable for inspection and cleaning of the bearings.

The expansion rollers are 6 in. in diameter at the abutments and are also provided with alignment gears and curtain plates. The expansion bearings at the abutments are in Fig. 1. The fixed bearings at Pier 3 are similar to the expansion bearings at Pier 2, except for rollers and bed plates.

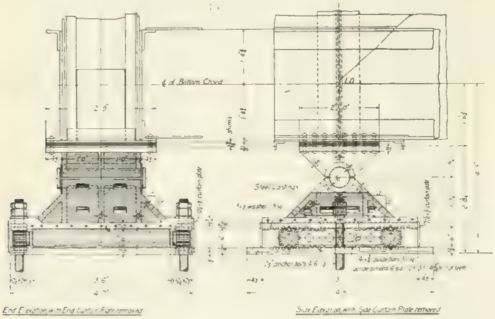
℄ of Bottom Chord
2' 9"
1'0"
shims
Steel castings
curtain plate
anchor bolts
End Elevation with End Curtain Plate removed
Side Elevation with Side Curtain Plate removed

Fig. 1—Expansion Bearings at Abutments of Kettle Rapids Bridge.

The bridge seats are tool dressed, perfectly level and to the exact elevations called for on the drawings. Sheet lead ⅛ in thick is provided to equalize any minor irregularities of the surface.

The Kettle Rapids single track railway bridge is a continuous structure 1,000 ft. long, having a channel span of 400 ft. and two side spans each of 300 ft. It was designed by W. Chase Thomson, Consulting Engineer, Montreal, Que.

**Timber Bridges 80 Years Old.**—In an article in the August Public Roads, Mr. O. L. Grover, Bridge Engineer, U. S. Bureau of Public Roads, states that there are a large number of wooden bridges in the eastern and southern states from 40 to 60 years old, that are still in a good state of preservation. One example is the wooden bridge, with a span 280 ft. long, over the North River, at Bridgewater, Va., which was built in 1866. The timbers are mostly hewn pine. Another bridge is in Jessamine County, Ky., over the Kentucky River. This was built in 1838. It was constructed of hewn timber, cut in the mountains and floated down the river to the site.

**110-Ft. Barge Completed in 15 Working Hours.**—What is claimed to be a world's record for barge building was made recently by the National Shipbuilding & Dry Dock Co. of Savannah, Ga., by completing a barge in 15 working hours. The craft is 110 ft. long, 32 ft. wide, with 70-ft. masts, and is one of 35 similar vessels being built for this company for the Government. The former speed records for barge construction was held by a New York plant which built a hull in 22 working hours.

# Methods of Repairing Old Stone Masonry

A number of old structures on the Boston & Maine R. R. have been repaired by buttressing and reinforcing bulging or otherwise defective masonry with iron or concrete or both. The method employed in this work was described in a committee report submitted last week at the convention of the American Railway Bridge and Building Association.

In one case a flared wing about 75 ft. long of a comparatively large stone arch over a stream bulged to such an extent at the center about midway between the top and bottom, as to make the road uneasy about its safety. This wing was about 35 ft. high where it joined the spandrel wall of the arch and was stepped down from full height near the track, to a height of 4 or 5 ft. at the outer end. About 15 wooden piles were driven in two rows in front of the wing where the maximum bulge was located. These piles covered a rectangular area about 8 ft. wide and 16 ft. long parallel to the masonry. They were enclosed by a wood cofferdam, which was unwatered and the piles cut off at the water line. The cofferdam was then filled with concrete, and scrap track rails, set vertically at about 2-ft. centers, close to the old masonry, were embedded in it. A block of concrete was then cast, encasing the rails battering from the outside line to the cofferdam to a width of about 3 ft. at the level of the maximum bulge. No movement of the masonry has been noted since this was done about two years ago.

In another case, the crowns of a three-centered double-track stone arch bridge of two 20-ft. spans laid dry, began to flatten in the center of each arch. This structure was constructed over a stream with the track grade only 3 or 4 ft. above the crown of the arch rings. The abutments, pier and wings showed no evidence of movement or distress. Repairs to this bridge were made by building a temporary wooden deck under the tracks, supported on pile bents back of each abutment and a timber bent over the center of the pier to carry traffic. This construction permitted the removal of the earth filling and ballast from the tops of the arches. Timber forms made to fit the original curve of the arches were placed under them and the deformed arches were jacked back to the original shape and position. All joints were washed out clean with a force pump and thoroughly grouted with cement. An examination of the structure disclosed the fact that the thickness of the abutments at the spring line was not sufficient to stand the thrust of the arches according to accepted practice and additional concrete was added to provide for this. The earth covering was then replaced on the arches and in the rear of the abutments and the false work removed. This work was done about 10 years ago and no settlement has since been noticed.

Stone masonry piers which showed evidences of failure have been repaired and strengthened by placing track rails in pairs, vertically on each side of them, tying them together by placing rods through the piers between each pair of rails, secured to the rails by heavy bent washers on the outside of the rails, with nuts on each end of the rods. The entire piers were then encased in concrete 12 in. to 18 in. thick and have since given satisfaction.

Repairs to high spandrel or parapet walls on old stone arches, carrying single or double tracks which have been pushed out by the increased weight of rolling stock, have been repaired by drilling holes in pairs through the spandrel walls opposite each other about 4 ft. below the tops of the ties, excavating trenches under the tracks opposite the pairs of holes and providing rods about 1½ in. in diameter with turn buckles in the center and nuts on each end. These rods were anchored to the faces of the walls by pairs of rails as above described, or by heavy iron plates set in the face of the masonry. The nuts and turn buckles were then screwed tight and the rods encased in concrete.

A convention of contractors and building supply dealers is being held at Ottawa, Ont., Oct. 22-24, for the purpose of organizing the Canadian Association of Building Industries.

# Street and Highway Bridge Policy of U. S. Highways Council

The policy of the United States Highways Council for street and highway bridges is outlined in a Bulletin made public on Sept. 23. The bulletin follows:

In view of the absolute necessity of providing for military and naval purposes such large quantities of steel and iron that the use of these materials even for the indirect war needs of the federal government has been necessarily curtailed, often against the strong protests of government engineers, it is the opinion of the United States Highways Council that the street and highway bridge policy of all sections of the country should be based until further notice upon the following principles:

(1) Every endeavor should be made to keep existing structures in service by all available means, such as

- (a) Effective supervision
- (b) Suitable repairs.
- (c) Control of traffic.
- (d) Prohibition of use of bridges by street car, road rollers, traction engines, and other heavy vehicles.

(2) The possible relief of a weak bridge by a detour utilizing a safe structure should be investigated. The improvement of such a detour by using materials which can be obtained without serious delay may be preferable as a war-time measure to the reconstruction of a steel bridge.

(3) In some sections of the country the urgent government requirements for cement are now very heavy. Public officials should not forget that materials like cement and brick, which require fuel for their production, cannot now be turned out in the same quantities which were made in peace times, for the fuel is needed in war industries and for absolutely necessary civil purposes. Consequently, public officials are not justified in assuming that if they change their plans for proposed structures from steel to concrete, it will be possible for them to build new bridges without any difficulty.

(4) If public officials find that it is impossible to maintain existing structures and cannot substitute temporary bridges for those that are unsafe, they should apply to the United States Highways Council through their State Highway Departments for approval of their projects. An application should be made out for each bridge on forms obtainable from the State Highway Department. With each application there should be a statement of the size and date of construction of the bridge, the conditions of the piers and abutments, any stream conditions such as floods or caving banks which affect the maintenance or reconstruction of the bridge, the local materials available for bridge work, and evidence of the impossibility of maintaining the present structure or substituting a temporary structure of materials obtainable without government assistance. Public officials are reminded that the United States Highways Council looks to them for assistance in reducing to the absolute minimum the bridge materials required.

(5) The Council contemplates three classes of bridge projects which appear worthy of favorable consideration during the war period.

1. A bridge urgently required as a military necessity and so recommended by the representative of the War Department to the United States Highways Council.
2. The replacement of an unsafe bridge which can not be made safe through suitable repairs, traffic regulations, or detour.
3. Replacement of a bridge which has been destroyed and which is essential as a direct or indirect war need.

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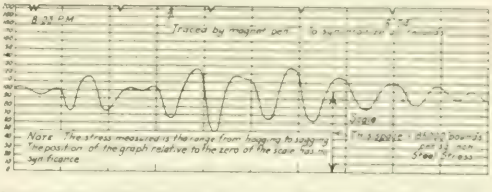
**Sixty Per Cent Capacity of Structural Shops Contracted For.**—The records of the Bridge Builders & Structural Society, as collected by its secretary, show that during the month of September, 1918, 60 per cent of the entire capacity of the bridge and structural shops of the country was contracted for.

# Instrument for Recording Strains in Ships

A new device to record the [illegible] of a ship developed by F. R. McMillan, research engineer of the Concrete Ship Section, and H. S. Loeffler, assistant research engineer of the section, is described in a recent issue of the Emergency Fleet News. The apparatus was tried out on the concrete steamer "Faith" on her first voyage and the chart reproduced herewith shows the strain the "Faith" underwent during one minute of a severe storm.

The strainagraph is built somewhat on the principle of the seismograph and was designed primarily to test out the qualities of the concrete ship. The strainagraph is attached at any point in a ship where it is desired to know the strain. The series of levers which multiply 140 times any movement transmitted to them is actuated by a plunger bar fixed to the ship at a point 40 in. distant. Thus the distance recorded on the chart is 5,600 times the actual movement in any one inch of length.



Copy of Chart Recorded on Concrete Steamer Faith in Midst of a Storm.

The chart showing the record made during the voyage of the "Faith," it will be noted, has a line at the top with breaks at intervals. Attached to the instrument is a clock which serves to measure on the chart the time during which the record is produced. Every double break in the top line marks the end of a minute and every single break the passing of a quarter of a minute. This chart shows a strainagraph record taken between 8:03 and 8:04 p. m., on May 24, 1918.

The recording pen which recorded the zigzag line in the center of the chart travels upward when recording compression and downward when recording extension.

The instrument on the "Faith" was located amidships on a longitudinal deck beam about midway between hatches 2 and 3 on a line along the port side of these hatchways.

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# Local Engineering Society Amends Constitution to Provide for Joint Membership With Other Societies

The members of the Cleveland Engineering Society on October 8 by a vote of 20 to 1 authorized the amendment of the society's constitution so as to provide for joint membership with other societies. Under the plan some 40 members of the Cleveland society already have become members of the American Association of Engineers. Another local engineers' society is now considering the adoption of this plan. The constitutional amendment as adopted by the Cleveland society follows:

> Agreements may be made by the Executive Board, subject to approval by [illegible] of the members, with any engineering or technical society of the United States or Canada [illegible] [illegible]
>
> A member in good standing of the other society [illegible] his application and election as provided for other applicants for membership, but without payment of an entrance fee. He shall [illegible] terminate with the end of the fiscal year of The Cleveland Engineering Society, and thereafter shall pay regular joint membership dues.

## New Regulations of Building Materials Section for Use of Pipes. Tanks And Accessories in Government Projects.

In order to conserve iron and steel for the war program the Building Materials Section of the War Industries Board on Sept. 27 adopted regulations governing the use of pipes, tanks and accessories in Government projects under way and under consideration. It is estimated that these regulations will effect a saving of 40,000 tons of pig iron. The regulations follow:

1. Nothing larger than 4-in. diameter nor heavier than standard plain cast iron soil pipe is to be used for vertical stacks above ground; the full size stack to be carried through the roof. Portland cement concrete or vitrified clay pipe shall be used for horizontal lines under ground.

2. There shall be no back vents used.

3. No house traps or fresh air vents shall be used.

4. Water service pipes shall be of ¾ in. galvanized wrought steel or iron for single houses, and of proportionately larger size for larger buildings.

5. No patterns for soil pipe and fittings other than those listed in the schedule of the Conservation Section of the War Industries Board shall be used.

6. The installation of gas piping in houses will not be permitted where electricity is available for lighting purposes. This will not prohibit the installation of gas piping for heating and cooking purposes where the extreme extension of the distribution mains to the houses is less than 1,000 ft.

7. No system of gas mains shall be installed in any project requiring an extension of more than 1,000 ft. from the existing source of supply without the special approval of the War Industries Board.

8. No metal pipe shall be used for water mains without special permission of the War Industries Board. This does not apply to pipe lines carrying pressures of more than 100 lb

9. The number of fire hydrants shall be reduced to the absolute minimum necessary for adequate fire protection.

10. All water supply tanks shall be of other material than metal.

11. Culvert pipes shall be of reinforced concrete burned clay, or other material than metal.

12. Cellar floor drainage shall be restricted to the use of underground drains which may be turned up to the floor level and finished with a screw plug connection.

The above regulations shall not preclude the use of existing manufactured stocks provided the metal cannot be utilized for more essential war purposes.

## Speedy Framing of Ferris Type Hull

The Sanderson & Porter yard at Raymond, Wash., early in September completely framed a Ferris type hull in 29 hours and 40 minutes, using 63 men, or 1,869 man hours. The work was begun at 3 p. m., Sept. 3. The time worked and the progress of framing was as follows:

| Date. | Hours worked | Frames erected |
|---|---|---|
| Sept. 3 | 2 | 1 |
| Sept. 4 | 6 5-6 | 10 |
| Sept. 5 | 8 | 24 |
| Sept. 6 | 8 | 26 |
| Sept. 7 | 4 5-6 | 14 |
| Totals | 29 hours 40 min. | 75 |

On Sept. 4, 1 hour and 10 minutes was lost on account of compressor trouble (no air). The maximum force in any way connected with the work of building and erecting the frames was as follows:

| | |
|---|---|
| Foreman | 2 |
| Carpenters | 17 |
| Fasteners | 14 |
| Helpers | 16 |
| Gantry crane crew | 4 |
| Setters | 3 |
| Shore and ribbon crew | 3 |
| Traction drivers | 2 |
| Water boys | 2 |
| Total | 63 |

No frames were assembled or built in advance of the time the work was started. On Sept. 6, 27 frames were built on one framing platform, 26 of which were set in place.

According to The Propeller, the official paper of the Grant Smith-Porter yard, Aberdeen, Wash., a Ferris type hull was completely framed at that yard in 1,452 man hours. The record on this work follows:

On Sept. 7, 14 of the frames, numbering 18 to 31 inclusive, were assembled and placed in position in 8 hours, with 30 men on the framing platform and 14 men placing frames—a total of 44 men, exclusive of the foremen. This work involved 53 bolts and 25 treenails in each frame.

On Sept. 9, 42 men, exclusive of the foremen, 32 of them being on the framing platform and 14 placing frames, assembled and placed in position 22 frames, numbering 42 to 63, inclusive, in 8 hours.

Assembling and setting up of square frames numbering 7 to 82, inclusive, in 52½ hours. Framing was started at 10 o'clock, Sept. 6, and the last frame was erected Tuesday, Sept. 10, at 3:30 p. m. The work was done in two 8-hour shifts, with an average of 45 men on each shift assembling and placing the frames in position.

Closing in hull on vessel, including placing and fastening of all frames, stem apron, knightheads, stern posts, rudder post, deadwoods, keelsons, shaftlog, and rim in two shifts of 8 hours each in seven working days. An average of 90 men were used in each 8-hour shift.

## Gantry Cranes at Detroit Shipyards

The Great Lakes Engineering Works is employing at its Detroit, Mich., shipyard. 6 gantry locomotive cranes of the type shown in the illustration. These cranes—all of the same capacity—are being used for handling material for the construction of steel vessels. The cranes have a maximum radius of 86 ft. and a minimum radius of 22 ft. The length of boom, center to center of pins, is 85 ft. The capacity at the 86-ft. radius is 7,000 lb. The hoisting speed full load is 250 ft. per minute, the traveling speed is 125 ft. per minute and the revolving speed, 5 revolutions per minute. The cranes are steam driven and have an oil burning attachment connected to the boiler. All motions of travel, hoisting, swinging, raising and lowering of boom are controlled from the operator's platform in the cab. At the Great Lakes yards the cranes are being operated in three 8-hour shifts. The crane operator and fireman are each paid 72½ ct. per hour. The coal consumption is around 1,200 lb. per 10 hours, and the water used amounts to 1,000 gal. in 10 hours. The cranes were furnished by Orton & Steinbrenner Co., Chicago, Ill.

Gantry Locomotive Crane at Shipyard of Great Lakes Engineering Works.

# Bridge Construction with Timber, Concrete and Stone Under Present War Conditions*

In many communities culverts and bridges need to be built, even under war conditions, to keep the highways in shape for use, even where no new road construction is under way or would be authorized.

Steel has been the favorite bridge material for several years. It has been used for small as well as large structures. At present steel is not available in any quantity for bridge construction. It can not be had at all where its use can be avoided, while all large steel construction necessarily must be abandoned or postponed until peace and normal conditions return. This situation forces the use of other material, timber, concrete, stone, and brick.

For long bridges and for temporary work where the cost must be kept down regardless of high maintenance expenses, timber is the material which must be used for superstructures. In small, permanent structures concrete, stone, and brick are excellent materials, preferably in the order named. The character of the structure should be governed by the material most readily obtained, though in some instances the available labor may be the determining factor.

**Culverts of Rubble Masonry.**—Small structures, built even under the present war conditions, should be constructed with a view to permanence. Culverts with small spans can be built readily without the use of steel, and of the most substantial construction.

In locations where suitable stone can be procured culverts of rubble masonry with stone covers may be constructed where the spans do not exceed 4 ft. Such culverts will prove satisfactory and will last for a long time. The construction is simple and where suitable stone is found in the neighborhood within easy hauling distance the cost should be reasonable. In the selection of the stone the most durable should be used.

The following table gives the thickness and width of cover stones for culverts of 2, 3, and 4 ft. spans:

DIMENSIONS OF COVER STONES

| Span in feet | Thickness in inches | Width in inches | Length in feet |
|---|---|---|---|
| 2 | 8 | 18 | 4 |
| 3 | 12 | 24 | 5 |
| 4 | 15 | 30 | 6 |

The masonry walls should be laid in cement mortar, and the stone slabs composing the cover should be laid in mortar beds and the cracks between stones filled with mortar.

Rubble stone suitable for masonry is found in many localities, where there are no stones suitable for the cover. Where this is the case the top may be made of reinforced concrete. This will require a small amount of steel reinforcement, but will permit the use of a longer span than is safe with the flat stone top.

While suitable stone for the rubble masonry is to be found in many sections throughout the country there are many places where it can not be obtained. In some localities it may be desirable to substitute plain mass concrete in place of the rubble masonry, because of the difficulty in obtaining suitable stone.

**The Construction of Arches.**—Where it is necessary to make longer spans the arch is the only type of permanent structure that can be built without metal. The height needed and foundation conditions are the controlling features in this construction. The arch span will not prove substantial without a good solid foundation, either of cemented gravel, hardpan, or rock. So important is this in securing permanency that the arch should not be selected until after the most thorough examination of the location. In some streams the bed is of such a character that there will be no great difficulty in securing the proper foundation. In others all sorts of conditions may exist and make it difficult to provide one.

Where it is possible, the foundation should be on solid rock. Where this is not possible, it is often practicable to secure adequate foundation by carrying the foundation deeper, by driving piles or sometimes by spreading the footing over a wider area. In all cases where solid rock is not found the problem should be submitted to an engineer for solution.

The three materials most used in arch construction are concrete, stone, and brick, preferable in the order named.

It is necessary to carry the foundations well below the bed of the stream. For the smaller spans this should not be less than 1 ft. 6 in. and for the longer ones not less than 2 ft., unless they are laid on a bed of solid rock. Riprap and channel paving should be provided where it is necessary to prevent scour.

In building arches of stone or brick, the top of all masonry should be protected by copings of concrete or by copings of large, selected stone with grouted joints.

In the South, where the climate is not subject to hard freezing, common hard burned brick may be used in building arches, but should not be used where good rubble stone is to be had. In the colder sections of the country brick does not give as good results, because it absorbs moisture and disintegrates by freezing.

The foundations should be carried to good firm material, and have a minimum depth below the bed of the stream of 1½ ft. unless on solid rock. The brick should be laid in cement mortar and be covered with 1 in. of cement mortar troweled smooth.

**Timber Trestles and Bridges.**—Timber may be used with satisfactory results for both temporary and permanent structures, and to good advantage where brick, stone, and concrete are not easily secured. There is hardly any part of the country where good timber can not be obtained, and for spanning streams of considerable size the timber trestle or bridge is the usual type of construction under emergency conditions. It is often hard to draw the line as to just what is meant by temporary and permanent structures. Roads and bridge building are determined by the expected uses, the necessity of early completion, probably most often by the available funds. At present the labor available must also be a controlling factor. Bridges will be built to last as long as they will perform the required service, though it may be expected to replace them with better and more permanent structures when additional funds are at hand or conditions warrant.

Timber deteriorates unless protected or treated for preservation, and for that reason is recommended only for temporary structures and where other materials are not available. The ordinary life of a timber trestle or bridge can be practically doubled by a good preservative treatment, and if the structure is expected to remain in use beyond the natural life of the wood it may be advisable, in order to keep down heavy maintenance expenses, to use a preservative treatment.

Bridges may be built of timber to serve any purpose required and will last many years. They can not be so economically maintained as bridges of reinforced concrete, but so long as it is not practical to make use of reinforced concrete the timber structure will be the one to build, but it must be borne in mind that it should rest on permanent foundations.

In timber construction the most durable timber should be used that can be obtained locally. The general type of temporary construction is the trestle.

The more available timbers with a fiber stress of 1,600 lbs. per square inch include long-leaf pine, white oak, and Douglas fir. In the 1,400-lb. class is included Pacific post oak, Western larch and tamarack; in the 1,200-lb. class bald cypress, Norway pine, and hemlock, and with a fiber stress of 1,000 lbs. per square inch red spruce, chestnut, and red cedar. Piles used should be yellow pine, cypress, white oak, or some equally durable species.

**Construction Under Present Conditions.**—In meeting the present-day conditions limiting the construction of bridges local supplies of material and labor will be the determining factors. In general, the decision as to construction should be as follows:

Keep large structures in service by repair, whenever it is possible.

Put temporary spans on permanent substructures.

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*[illegible]

Put in temporary trestles where it can be done.

Small structures should be made permanent.

Where large structures are destroyed and must be replaced to keep the road open or where emergency use requires the building of a new crossing make temporary pile trestle structures if the nature of the stream does not make this type impracticable. Where temporary structures are not advisable timber structures may be protected so as to be more or less permanent.

## Rivets and Riveting in Hell Gate Arch Bridge

The following information on the riveting for the Hell Gate Arch Bridge is abstracted from the Proceedings of the American Society of Civil Engineers, pages 1718-19:

There are, in the whole arch bridge, about 840,000 shop rivets and 334,000 field rivets, of which 400,000 are 1¼ in. in diameter. Most of the 1- and 1¼-in. shop rivets were driven with hydraulic riveting machines having a pressure capacity of 100 tons (100 lb. per sq. in.). The output of one of these machines is about 3,500 rivets per day. For all heavy field rivets and such shop rivets as could not be driven with pressure machines, pneumatic riveting hammers of the No. 90 Boyer type with 9-in. stroke and pneumatic buckers-up were used. The points of the long rivets had to be dipped in water, after heating, so as to insure more complete upsetting of the shank before the head was formed.

The specifications required the rivets to be of such a diameter that it was necessary to force them into the holes with a hammer when hot. Experience has shown that rivets which drop easily into the holes when hot, especially those of long grip exceeding about three times the diameter, cannot be relied on to fill the holes completely after upsetting. Such rivets may seem tight when tested with a hammer, but when cut out often show incomplete upsetting near the middle of the shank and toward the shop-formed head. The specifications further prescribed that rivets with a grip equal to, or exceeding, four times the nominal diameter should be tapered so that the base of the rivet should be 3/64 in. larger and the point 1/64 in. smaller than the nominal diameter.

Experiments showed that such rivets, when smooth and of perfect size, and the holes exactly 1/16 in. larger than the nominal diameter of the rivets or 1/64 in. larger than the actual diameter at the base, can be driven without scraping the hot metal of the shank and forming a film under the rivet head and fill the holes more perfectly than ordinary cylindrical rivets. It was found, however, that allowance had to be made for the irregularity in diameter of rivets and holes due to the rapid wear of the rivet dies and the drills. After extended experiments, the following size and shape was finally adopted for the 1¼-in. rivets: Minimum diameter under the head, 1 9/32 in., tapered down to 1 15/64 in. in a distance of from 5 to 6 in. from the head, depending on the length of the rivets, the rest of the shank being cylindrical.

The rivets were required to be perfectly round, and free from loose scale and projecting fins, and before they were entered into the holes, the scale, formed in heating, had to be carefully scraped off. To produce perfectly round and smooth rivets, it was found necessary to deviate from the ordinary practice of upsetting the rivet between dies by a single stroke of the machine and cutting it off at the same time from the feeding rod. Pieces of the proper length required for the various rivets were cut cold from the rivet rods and, after heating, were placed individually into the upsetting machine. Each rivet was given at least two strokes, and was turned after each stroke, so as to make it perfectly round and press down the projecting fins which form in the first stroke at the joint between the dies. Further, by more careful individual handling of the rivets in the heating furnace, it was possible to avoid the scale which often forms on the rivets due to improper heating when handled in bulk. Whatever slight scale was left was removed by running the finished rivets through a rumbling process and, where necessary, projections were removed by grinding.

## The United War Work Campaign

The people of the United States will be asked this fall to share as a unit in the great task of caring for the fighting men. In the United War Work Campaign from November 8-11, $170,500,000 will be raised as a service offering from the civilian army to their military and naval representatives. It is a call for unified support of the organizations which at home and in the fighting zones have sought out the individual and helped him to keep his courage and his efficiency. The agencies joining in the drive are the Young Men's Christian Association, the Young Women's Christian Association, the National Catholic War Council, the Jewish Relief Board, the War Camp Community Service, the American Library Association, and the Salvation Army.

## Personals

**John F. Druar,** consulting engineer, St. Paul, Minn., is now captain of engineers, 417th Engineer Regiment, Camp Dodge, Iowa.

**A. A. Daugherty** of the National Shipbuilding Co. of Texas, Orange, Tex., has been elected president of the Chamber of Commerce of Orange.

**Thomas J. Sauerhoff,** for several years superintendent of construction of the Delaware Shipbuilding Company's plant at Seaford, Del., has resigned.

**Harold G. Beers,** vice-president and chief engineer of the Southern Ferro Concrete Co., Atlanta, Ga., has been commissioned a major in the Construction Division of the Army.

**J. C. Ford,** assistant supervisor of wooden ship construction and L. E. Geary, architect in the wood shipbuilding department, of the Emergency Fleet Corporation offices at Seattle, Wash., have resigned.

**A. C. Bell,** of the Wisconsin Bridge Co. was elected president of the Society of Iron Fabricators of Milwaukee at the annual meeting last week. The other officers are: William Hackendahl, Hackendahl-Schmidt Company, vice-president; Robert W. Reed, Lakeside Bridge Company, treasurer; E. F. Zuleger, Worden-Allen Company, secretary.

**S. C. Tanner,** of Baltimore, Md., has been elected president of the American Railway Bridge & Building Association, which held its convention at Chicago last week. The other officers elected were: First vice-president, Lee Jutton, Chicago; second vice-president, E. E. Weise, Chicago; third vice-president, W. F. Strouse, Baltimore; fourth vice-president, C. R. Knowles, Chicago; secretary-treasurer, C. A. Lichty, Chicago.

**W. W. Coleman and T. H. Symington** have been appointed Special Assistants to the Chief of Ordnance, U. S. A. Mr. Coleman will have charge of all matters connected with the production of cannon, carriages and their appurtenances and accessories. Mr. Coleman has been president of the Bucyrus Co., of South Milwaukee, Wis. He has been with the Production Division of the Ordnance Department since last spring. Mr. Symington will have charge of artillery ammunition, metal components, but will have nothing to do with the loading plant operations. He is a member of the firm of Symington-Anderson Co., of Rochester, N. Y., manufacturers of Ordnance material.

## Obituaries

**Daniel B. Rogan,** engineer for the Port Commission of New Orleans, died Oct. 10, aged 34.

**S. H. S. Raub,** vice-president of the Lehigh Structural Co., Allentown, Pa., died Oct. 8, aged 28.

**William A. Stern,** of the building and contracting firm of W. A. Stein & Co., Allentown, Pa., died Oct 12, aged 41.

**James H. Harlow,** formerly engineer of the Harlow Bridge Co., of Pittsburgh, Pa., died Oct. 6, at his home in Darlington, Md., aged 72.

**Murdock Campbell,** a building contractor and at one time City Commissioner of Buildings of Chicago, died Oct. 11, aged 77. He erected many of the World's Fair buildings.

**Lieut. Robert S. Johnston,** aged 27, a civil engineer lent to the Canadian government by the United States government for duties in connection with the naval air stations on the Canadian Atlantic coast, died last week of Spanish influenza.

**Edmond M. Rhett,** a member of the engineering department of the du Pont Powder Co., died Oct. 10. He was graduated from the United States Military Academy in 1900. He served for a few years in the army as a first lieutenant of engineers. Afterward he specialized in electrical engineering and had charge of the building of the shops of the Central Railroad of Georgia.

**Capt. F. B. Laramie,** of the Construction Department at Camp Humphrey, Washington, D. C., died early this month. He was a captain in the engineering corps under Gen. Miles in the invasion of Porto Rico, and when the United States declared war on Germany he joined the engineering unit at the municipal pier, Chicago, and from there went to Camp Grant, where he aided in superintending the construction of that cantonment. Later he went to Camp Wadsworth.

## Industrial Notes

**The Chicago Pneumatic Tool Co.** announces the election of H. D. Megary to the office of secretary, vice W. B. Seelig, resigned.

**William Cetti,** for over 25 years representative of the Thompson Meter Co. of Brooklyn, N. Y., has resigned his position with that company.

# *British Engineering Review Issue*

# ENGINEERING AND CONTRACTING

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering field.

**Roads and Streets—1st Wednesday**
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies

**Waterworks and Hydraulics—2nd Wednesday**
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power

**Railways and Govt. Works—3rd Wednesday**
(a) Excavation and Dredging (c) Harbors and Docks
(b) Rivers and Canals (d) Railway Construction

**Buildings and Structures—4th Wednesday**
(a) Buildings (c) Ship Construction
(b) Bridges (d) Miscellaneous Structures

Volume L. CHICAGO, ILL., OCTOBER 23, 1918. Number 17.

## Our Second British Engineering Review Issue

The first British Engineering Review issue of Engineering and Contracting was published three months ago, and was so well received by our readers that a second issue of the same kind is now given by them.

We shall publish three foreign engineering review issues in 1919 and one "new equipment issue," all of which will be sent to our monthly subscribers as well as to our weekly subscribers.

No other periodical in America is systematically summarizing foreign civil engineering and construction progress; yet there is a great deal that Americans may learn, both in theory and practice, from other countries.

Our next special quarterly number will be our New Equipment Issue, which will appear the last Wednesday in January. It will contain illustrated descriptions of every new device and every important improvement in any old device that has been effected in America during the year of 1918 in the broad field of civil engineering. Whenever we speak of civil engineering broadly we include the construction as well as the design of civil engineering works, and therefore include contracting.

As the present issue shows, civil engineering progress has not been greatly retarded in Great Britain by the war, and, in fact, has been accelerated in many respects. After the close of the war, which is now at hand, we may confidently look for great renaissance, or rebirth, in pure and applied science throughout Europe. Upon this prospect we have commented at some length in another editorial.

## The Effect of War on National Wealth

War has commonly been regarded as the worst of national ill-winds. Political economists have always painted the dreary pictures of the wealth destroyed by war. Yet, in spite of great material losses, nearly every important war has been followed by a prosperity that was astonishing to those who had forecast disaster. The reason has been that wars have usually caused a marked mental quickening, amounting to a veritable renaissance of the spirits of those who survived the blasts of battle. This mental rebirth has usually resulted in so great an industrial progress following the war that the war's losses were speedily repaired.

The entire wealth of a nation is, after all, not enormous even beside the gross annual income of all its people. The gross annual income of all Americans is some fifty billion dollars, and our total wealth is only five times that sum. Only a negligible part of the wealth of the belligerent nations has been destroyed by war. America has lost so little wealth so far that it is scarcely worthy of mention. Great Britain's loss of wealth has been mainly in ships, yet that does not amount to two billion dollars all told. A recent estimate of the cost of completely rehabilitating France was less than five billion dollars. When one's economic perspective is not distorted by too close a view of large figures, it is seen that the actual losses of wealth through the greatest of wars are relatively not great.

Wealth changes hands during every war, frequently to such an extent that many individuals are impoverished, but the total wealth tends to increase in spite of the war. Usually the increase in total wealth during a war is below normal, but the significant fact is that there is an increase. The wealth of a nation consists mainly of the lands (including minerals), the live stock, the buildings, the furniture, the highways of all kinds, the machinery (including all apparatus and tools), the water works, the sewers, the stocks of supplies on hand, the gold and silver and the wearing apparel. Certificates of wealth—stocks, bonds, notes, paper money, bank credits, and the like—are not national wealth, but merely show the share of the national wealth owned by individuals and corporations. During war it is the rapid change of ownership of these wealth certificates that leads many intelligent people to think that war is destroying vast wealth.

In normal times, and when the general level of prices is stationary, national wealth has seldom increased more rapidly than at the rate of 4 per cent annually; and, since our population increases about 2 per cent annually, it follows that national wealth normally increases only 2 per cent per capita per annum. Since our national wealth is about $2,500 per capita, it follows that the normal annual increase in per capita wealth is only $50. Our per capita gross annual income is about $500. Hence the average American permanently saves one-tenth of his gross income. The effect of the war in Great Britain and America has been to increase prices so greatly that comparisons of wealth before the war and now mean nothing if expressed merely in dollars. But statisticians are agreed that, after

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making proper allowances for increments in prices, the national wealth of each of these great English-speaking countries is greater now than it was four years ago.

We may confidently expect a rapid replacement of all the industrial plants, buildings, etc., destroyed by war. We may also count upon an unprecedented boom in the civil engineering field soon after the close of this mighty conflict. It would be well were engineers able to persuade public officials that the time has already come to make preliminary surveys and estimates for public works. A horde of men will soon be out of a job. It is the part of patriotism, as well as of political economy, to begin now to prepare useful work for their heads and their hands to do.

## Let Us Study the Work of Foreign Engineers and Contractors

The war has caused both Britains and Americans to draw their belts tighter and work harder; and it has spread the habit of thrift. But important as this result is, even more important has been the great mental stimulus. We have felt this stimulus less than our cousins across the sea, but we, too, have had a mental quickening that will be lasting in its effect. The clash of war has been a clash of wits as well as of steel. When the smoke clears, it will be seen that the minds of men have been turned toward science as never before. Engineers are the leaders in applied science; indeed every applied scientist is an engineer of some sort. European civil engineers have always been able to teach American civil engineers many things, but we have not always shown much desire to be taught. Haven't we been, in fact, somewhat egotistic? Haven't we been too often given to bragging of American supremacy in civil engineering? Hasn't that bragging frequently led us to close our eyes to many things that Europeans were doing more efficiently? If European engineers have surpassed us in some respects in the past—and there is no doubt that they have—they are much more likely to surpass us in some other respects in the future unless we are quick to avail ourselves of their latest improvements.

It is a psychological fact that where rivalry is keen, a man dislikes even to study the reasons for his rival's supremacy in any particular. Instinctively he turns away or closes his eyes, and tries to believe that his rival can teach him nothing. Engineers, being human, are not entirely free from this mental frailty. But being scientific, they should know that frailty and guard against it.

Let us all resolve to study more carefully the methods of construction and the designs of the civil engineering works of foreign countries. Let us not be too hasty in "passing them up" because "our conditions differ from theirs"; for we should remember the logical rule: Conditions may vary extremely without altering a given cause-effect sequence, provided none of the varying conditions is an energy that enters into the given cause-effect.

Thus, the climates of two countries may differ enormously without affecting the design of a water pipe, or of an airplane, or of a telephone. "Conditions differ" is a poor excuse for not studying the experiences and methods of other men.

**Use of Soluble Silico Fluorides for Preserving Building Stone.**—In a paper presented December, 1917, before the Glasgow section of the Society of Chemical Industry, Dr. C. H. Desch reports very favorably on the use of soluble silico fluorides for the preservation of building stone. The method was, he states, first described by Kessler in the Comptes Rendus for 1883, and has been largely adopted in France. The double salt of aluminium and zinc is, he states, generally used. In the reaction with calcium carbonate insoluble compounds are formed. Highly porous limestones can therefore be rendered much more impervious by impregnation with these salts and their resistance to weathering greatly enhanced. The salts and compounds produced are colorless, so that the appearance of the stone treated is not changed.

## The Derwent and Howden Dams

From Engineering.

The Howden and Derwent Dams, designed and built by Mr. Edward Sandeman, M.Inst.C.E., for the Derwent Valley Water Works, are excellent examples of most difficult—and successful—construction undertakings. These two dams are very similar in design and appearance, the differences lying in dimensions only. Their cross-section is given in Fig. 1. The lengths on the top water line are 1,080 ft for the Howden Dam and 1,110 ft. for the Derwent Dam, while the heights above the river bed are 117 ft. and 114 ft., and the widest parts of the foundation are 117 ft. and 114 ft. respectively. Practically, they are alike, the only difference possibly noticeable to the eye is that the central overflow weir is 500 ft. in length in the Howden Dam, and 600 ft. in the Derwent Dam, the latter, being lower in the valley, having, naturally, to pass the greater quantity of water. The compensation water to be given to the River Derwent was fixed by referees appointed by Parliament at 15,209,000 gal. per day.

The geological formation of the valley, even if it had been good of its kind, was not ideal to carry a great dam. The tops of the hills are millstone grit, which is a very serviceable rock, but it is all above the level of the excavation. Below it comes the Yoredale rocks, which are a miscellaneous collection of beds of shale, alternating with beds of sandstone, the former ranging from several feet to a few inches in thickness, and the latter usually less than 2 ft. in thickness, but occasionally attaining 7 ft. to 8 ft. Unfortunately, the strata had suffered great disturbance in the past. Generally they were bent, but in the bottom of the valley the pressure of the adjacent hills had forced them to slip forward and to up-heave in a dangerous fault. It was on the very worst part of the faulting that Mr. Sandeman had to build his dams of more than 100 ft. in height. The valley sides, although not folded like the bottom, are, nevertheless, very disturbed and cracked, and have no pretentions to be watertight.

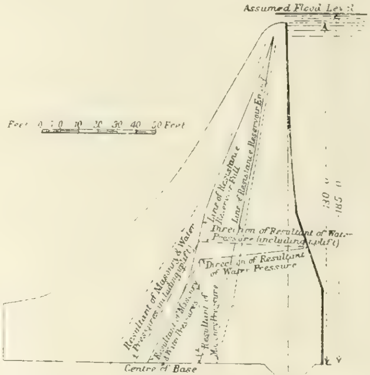

Assumed Flood Level
Feet 0 10 0 10 20 30 40 50 Feet
Line of Resistance Reservoir Full
Line of Resistance Reservoir Empty
130
185
Direction of Resultant of Water Pressure (including uplift)
Direction of Resultant of Water Pressure
Resultant of Masonry & Water Pressures (including uplift)
Resultant of Masonry & Water Pressures
Resultant of Masonry Pressure
Centre of Base
Middle Third

Fig. 1—Cross Sections of Derwent and Howden Dams.

In the center of the Howden Dam the excavation of the foundations was carried down to 70 ft. below the ground and even at this level the strata were not watertight, although they were quite capable of carrying the structure. There was no promise of immediate improvement if a lower depth were sought in the same way, while the increase in cost, due to the rapid extension of the width of the base was a very serious consideration. Mr. Sandeman, therefore, decided not to attempt to get a watertight joint between the masonry and the ground, but to sink an apron or curtain wall of moderate thickness to such a depth that it should rest on solid strata, or, at least, on strata under such pressure from above that percolation would not be dangerous. A trench 6 ft. wide was therefore carried down a further 55 ft. and filled with concrete to form a watertight barrier. This trench extended the whole length of the dam and ended in the east hillside at a depth of 190 ft. below ground, and on the west at a depth of [illegible] ft. The height of the dam from the deepest part of the main trench to overflow level, is 187 ft., and from the bottom of the narrow trench to overflow, 242 ft.

Security from leakage under the dam having thus been obtained, the ends had to be made tight. The usual plan is to carry the dam into the hills and to grout it into the firm rock. But headings driven several hundred feet into the hillside failed to find solid ground. The rock was broken up, and wide crevices existed, through which the water of the reservoir could have flowed in streams, probably exposing the flank of the structure, and making a new path for the river. It was, therefore, decided to carry two wing walls at right angles to the dam, and roughly parallel to the sides of the reservoir. The wing wall at the east side is 2,860 ft. long, and that on the west side, 2,600 ft., of which 1,007 ft. were tunnelled. The trenches are 5 ft. 8 in. wide, and are filled with 5 to 1 concrete. The total quantity of concrete in the east wing trench is 75,126 cu. yd., and in the west wing trench, 61,519 cu. yd.

There was a curious similarity in the conditions in the two dams, although they were some ¾ mile apart. In the Derwent Dam, the main foundations are 60 ft. below the river bed, as compared with 70 ft. at Howden. The 6-ft. trench or curtain well is carried down a further 38 ft., or 98 ft. in all. The height of the dam from the deepest part of the narrow trench to overflow level is 212 ft. The trench extends the whole length of the dam, and is carried into the hill on the west side for a distance of 605 ft., and on the east side for 792 ft. At the west end the trench terminates at a depth of 42 ft. below the river bed, or 156 ft. below the water-level of the reservoir. At the east end, the deepest part of the trench is 108 ft. below river bed, and 222 ft. below water-level.

The conditions of the wing walls in this reservoir were quite different from those at Howden, and the engineer had to find another method of meeting the danger of infiltration. He, therefore, determined to carry the wing walls direct into the hills, in continuation of the dam, and not at right angles to it, as at Howden. As already stated, the east wall was longer than the west, and proved to be a work of much difficulty, owing to the rapid dip of the strata into the hillside, and the great amount of water met with. Both here and on the west side the ends and bottom of the wing trenches were carefully grouted with cement under pressure.

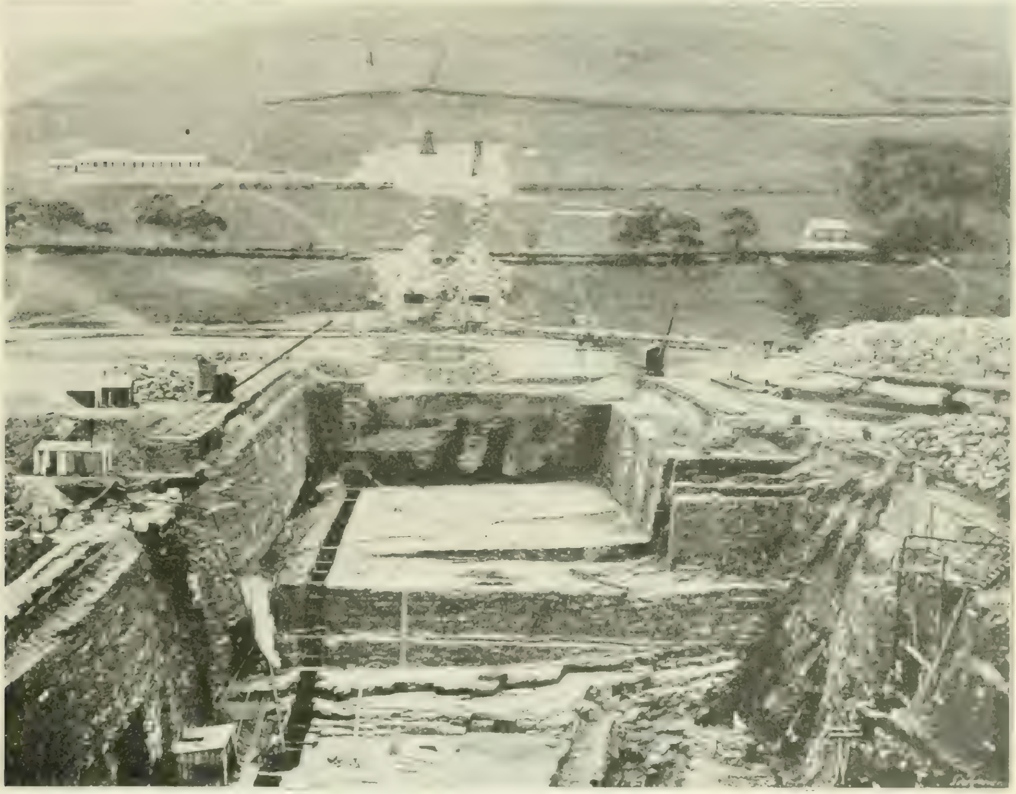


Fig. 2—Foundation Excavation for Derwent Dam.

The building of the dams was done piecemeal. A portion of the ground was excavated, and a large mass of masonry was laid down. In this was built, at the Derwent Dam, a culvert 19 ft. in diameter, large enough to take the river, and then the river was diverted through it, leaving all the rest of the valley free for further building operations. The culvert at the Howden Dam was 17 ft. in diameter, and the river was not diverted until the dam was built. The building of the dams went forward from the exposed face of the masonry, and gradually progressed across the valley, great care being taken in jointing the new portion to the exposed face. The concrete was 6 to 1 in the base, 5½ to 1 in the middle, and 5 to 1 in the upper and thinner part

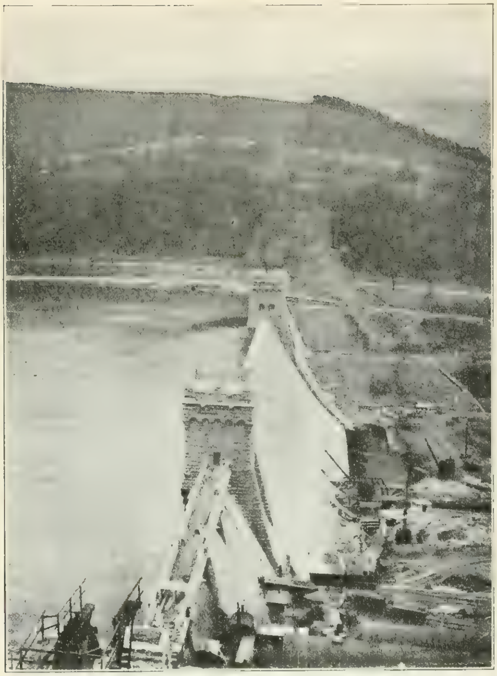


Fig. 3—Howden Dam Partially Completed.

of the structure. In it there were placed large rough blocks of quarried millstone grit, from ½ ton to 6 tons in weight.

The sites of the dams were each spanned by cableways capable of lifting 6 tons. The cables were composed of steel wires 0.156 in. in diameter, with an ultimate strength of 3,270 lb., and the circumference of the cables was 7 in. At each trench there were two cable ways, and each could be traversed sideways at one end, so that it commanded a triangular piece of ground, and as the movable towers were on opposite sides of the valley, the result was that a rectangular piece of ground was covered. The fixed end of the cable passed over a wooden tower, and was anchored to a concrete block in the ground; the other end was attached to a traveling tower, with a counterweight. These ropeways were used both for excavation work and also for bringing the concrete into position. The large stones were brought in wagons, and after being washed, were lifted into position by cranes running on elevated roads carried on piers which were eventually built into the dam.

The compensation water to be given to the river in respect of the portion of the water-shed controlled by the Howden and Derwent reservoirs amounts to 6,600,000 gal. per day, and it is discharged at the foot of the Derwent Dam. The water to be delivered for town use passes through the Howden Dam by two 36-in. pipes in the east tower, and through the Derwent Dam by three 45-in. pipes. In each dam there are six 30-in. discharges, three in each tower, for emptying the reservoir and for scouring purposes. All these pipes are controlled by valves worked from the towers. The main pipes lead to the filter beds at Bamford, and after the water has passed through them, it is conducted by an aqueduct 28 miles in length to the Ambergate service reservoir. This aqueduct consists of 17 miles of cast-iron and steel pipes, 7 miles cut and cover, and 4 miles of tunnel. For a part of its length it is carried on arches, alongside which a road bridge has been built. The cut-and-cover portion consists of a circular culvert 6 ft. 3 in. in diameter and made of concrete, having an internal lining of blue brick 4½ in. thick, with ½ in. of cement mortar rendering between the two. The concrete is 9 in. thick, with haunches to support the arch from the trench side. The gradient is 1 in 4,000, and when the water is 4 ft. 9 in. deep, the estimated delivery is 35,000,000 gal. a day.

## The Salaries of Science Masters

A letter in The Engineer.

I beg to direct the attention of your readers to an advertisement in a recent issue of your journal, part of which reads:

"Wanted, Senior Assistant Master to teach mainly Engineering Science. Science graduate preferred. Commencing salary £200."

One gathers from the rest of the advertisement that the duties include teaching at both day and evening classes. The next advertisement is for a Head Master for an Engineering and Trade School, and for the most generous salary of £350 per annum, it is stipulated that applicants shall have a British University Degree. Thousands of men and women are earning today wages equal to these for the performance of work which demands but a slight degree of training or skill of hand or brain. On the other hand, the Director of Education insists upon the need of teachers with imagination and enthusiasm and understanding of the high responsibility of their calling. Is it likely that men possessing not only high mental abilities, but that intuitive faculty of leadership which is necessary for success no less in business than in the teaching profession, will devote their attainments to the latter for wages little higher than munition workers? I hope the advertisers will get men as good as they deserve. I thank Heaven I am not a teacher!

Sheffield. J. WALMSLEY, A. M. I. Mech. E.

Fig. 4—Construction View of Howden Dam.

# Coagulants versus Sand Filters as Aids to Water Purification in the Field

BY CAPT H S BRIGGS, R. S., AND CAPT E. R. MARLE, R. A. M. C.

From The Royal Engineers' Journal.

The following is a description of an installation embodying the alum process which has now been at work for some months. The waterworks is situated in Flanders on a river highly charged with organic matter, and also, especially after rain, with very finely divided clayey material partly of a colloidal nature.

The works originally comprised a large settling tank, gravel pre-filters, sand filters of the ordinary pattern, and a clear water reservoir. As soon as construction was completed, it was evident the amount of water demanded would be largely in excess of that allowed for by the original design. It was also found that owing to the large amount of suspended matter in the water the sand beds speedily became choked, if the water was passed through at any other than a very slow rate. The length of time required for the sand filters to become "ripe" was also a drawback. It was therefore decided to clear the water as much as possible before delivery to the sand beds by precipitating the suspended matter with alum.

The process involves the addition of a solution of alum (Commercial Alumino-Ferric) to the water to be treated. Provided that the alkalinity of the water be sufficient, the addition of alum produces a white gelatinous precipitate of aluminium hydroxide, and this, mechanically, and by absorption, carries down with it not only the fine suspended matter, but also the colloidal matter, organic and inorganic.

Experiments of both a large and small scale having proved the efficacy of the process, four alum sedimentation tanks, each of some 40,000-gal. capacity, were constructed. These tanks were made by lining an excavation in the ground with tarpaulins, and were found perfectly satisfactory. Arrangements were made whereby the crude water could be discharged as required, into either of the four sedimentation tanks. The crude water discharge was led into a sloping wooden trough fixed at one side of each tank; into this trough was taken a feed pipe conveying the alum solution, the flow of which could be regulated by means of a stopcock.

A connection from the clean water main from the main pumphouse gave a supply of pressure water which was used for making up the alum solution in the raised tank and also for flushing through the alum feed pipes when necessary. A hose connection for washing out the sedimentation tanks was also provided.

The outlets from the sedimentation tanks were fixed a few inches above the bottom of the tanks and floating intakes have since been added. The alum treated water discharges were led to the original gravel prefilters, with connections to the clear water reservoir so that the gravel and sand filters could be cut out of the system if required. The bottom of each of the sedimentation tanks had a fall from the outlet end to a sump at the other end. When cleaning out was necessary the sludge was swilled down with a little water to the sump, and thence pumped out with a Merryweather to a drain.

The amount of alum used varied from 7½ to 15 or even 20 grains per gallon. This large proportion, as compared with that used in civil practice, was rendered necessary both from the excessively foul character of the crude water and also from the necessity of reducing as much as possible the time of sedimentation. The amount of alum required varied from time to time according to the turbidity of the water and atmospheric conditions. No precise rule could be found, and frequent experiment was therefore necessary.

The rule was stated some years ago that the quantity of alum to be used should be one-half the chemical equivalent of the alkalinity of the water (expressed as $CaCO_3$). This, with most Flanders waters, is in the neighborhood of 20 grains per gallon. In many cases, however, smaller quantities have been found quite satisfactory. The alkalinity of the water is an important factor in the process, and in cases where the alkalinity is below about 15 parts of $CaCO_3$ per 100,000 it is necessary to increase the alkalinity by adding a solution of lime to the crude water at the same time as the alum solution.

The sedimentation process in the installation described above was eminently satisfactory. The suspended water was deposited in from eight to twelve hours, leaving a perfectly clear supernatant water. The alum sedimentation was found to reduce the chlorine absorption in the subsequent chlorinating process, and the B. Coli content of the water was also to some extent reduced.

Water passed through the sand filters prior to the introduction of the alum process, although free from suspended matter, had a decidedly brownish appearance (the crude water was rich brown in color), and an objectionable musty or earthy taste. These characteristics appear to be due to organic substances of the nature of the "Albuminoid Ammonias." If such a water be chlorinated according to the requirements of the "Horrocks" test, although it may be safe, it is very unpalatable, and tastes strongly of chlorine. This taste persists even if there be absolutely no free chlorine present, and a great deal of trouble has been experienced from this cause in the case of water filtered through sand. It is believed that the objectionable taste is due to the products of the reaction between the organic substances in the water and the chlorine—to chloramines.

The water passing from the sedimentation tanks possessed none of the objectionable characteristics just described. It was clear, colorless, and its taste was good. Further, it could be efficiently chlorinated without a residual taste of chlorine remaining.

The alum-treated water, in the plant under consideration, was as a general rule passed through the sand beds to remove any solid matter that might have come from the alum tanks, but this procedure was for all practical purposes unnecessary, and in effect has frequently been dispensed with.

The alum tanks described have been working well for some months past, with an output which has on occasions reached 300,000 gal. per day.

The precautions necessary for the successful working of the alum process may be summarized as follows:

(1) The proper quantity of alum must be added in the form of a solution.

(2) A very thorough admixture of the alum solution with the water must be ensured. This admixture must be continuous and uniform during the filling of the sedimentation tank.

(3) The mixture of crude water and alum solution must be kept in motion during the filling of the tank. This can be done by causing the mixed water to enter and flow along one side of the tank with a certain degree of momentum.

(4) A warning must be given against confusion between the terms "alumino ferric" and "iron alum." Although the latter substance has a certain action as a coagulant, it is totally unfitted for the purpose. On one occasion a consignment of "iron alum" was in error supplied to the waterworks described, and "alumino ferric" not being available, had to be used, but with disastrous results. Alumino ferric is the trade name of the substance which should be employed.

It must not be supposed from what has been said, that precipitation of the suspended matter by alum is, in itself, sufficient for the production of a potable water. Whereas with the sand filter beds of civil waterworks practice, the removal of suspended matter and elimination of bacteria are effected at the same time, the alum process can only and should only be relied on to produce a clear water from a muddy source—although in the process the B. Coli content is appreciably reduced.

Further treatment is necessary to deal with the bacteria

The best agent for the purpose is chlorine, introduced either as a gas or in the form of a solution of calcium hypochlorite (bleaching powder).

Chlorine gas as an oxydizing agent appears to offer the following advantages over a solution of bleaching powder:

(a) A more delicate adjustment of quantities can be made.

(b) It is possible to add a larger excess of available chlorine without the taste becoming pronounced.

(c) Successive samples of bleaching powder are found to vary in their available chlorine content, whereas in the gas process pure chlorine and nothing else is introduced.

(d) The labor of making up the bleaching powder solution is avoided.

(e) Cylinders of liquid chlorine are more conveniently handled than corresponding quantities of bleaching powder and are less liable to deterioration.

The main difficulty in introducing the chlorine into the water is one of accurately measuring the dose. There are several varieties of apparatus constructed for the purpose but even the best require an expert operator, are difficult to repair, and are extremely expensive. The system by which a bleaching powder solution is introduced into the water to be chlorinated will probably meet all requirements in the field. In whatever way the chlorine is added, the admixture must be uniform and the chlorine should be in contact with the water for at least 30 minutes before test samples are taken. The longer the chlorine is in contact with the water before the latter is pumped into the mains the better, since there is thus less chance of an excess of chlorine remaining to impart an objectionable taste to the water and the very small quantities of chlorine admissible only effect sterilization when the contact period is relatively long.

The following are, in the writer's opinion, the advantages of the alum process over sand filtration plants, whether these be of the mechanical filter type, the large open sand bed type of civil practice, or the smaller quick filter of coarse sand such as have been installed in some instances:

1. Economy of Labor in Construction.—Alum sedimentation tanks are easily made of excavations in the ground lined with tarpaulins. The bulk of this work is unskilled. Sand filters of the usual type must be made of brick or concrete and require an enormous amount of work in proportion to the results attained. Mechanical filters require special machinery and plant and a good deal of skilled labor in erection. Heavy and substantial foundations must be provided. Quick filters of coarse sand cannot deal efficiently with a really dirty water.

2. Economy of Labor in Maintenance.—All filters require a large amount of labor to be expended from time to time in cleaning the sand beds and washing and renewing the sand, compared with the labor in removing sludge from the alum tanks.

3. Economy in Wash Water.—Alum sedimentation tanks require in proportion much less water for cleaning out than is required for washing the sand of sand filter beds, and dirty water can be used for the purpose if desired.

4. Character of the Water Produced.—As already stated, certain waters retain objectionable qualities even after passing through sand beds. Alum treatment will remove such characteristics.

**Pre-War and Present Prices of Road Material and Labor in England.**—In a paper presented last June before the Institution of Municipal and County Engineers Mr. J. A. Webb gave the following table showing comparative conditions and costs for pre-war and present conditions in the road field:

| | Pre-war. s. d. | Present. s. d. |
|---|---|---|
| Cost of granite per ton, carriage paid | 12 6 | 18 6 |
| Cost of flints per ton, carriage paid | 5 0 | 6 6<br>to 7 6 |
| Average cost per mile carting per ton | 1 0 | 1 9<br>to 2 0 |
| Horse, cart and man per day | 6 0 | 12 6 |
| Two horses, cart and man per day | 10 0 | 18 6 |
| Surface tarring per superficial yard | 0 1<br>to 0 1½ | 0 2½<br>to 0 3 |
| Roadmen's wages, per day | 2 8<br>to 3 0 | 5 0<br>to 5 4 |
| | No. | No. |
| Number of roadmen employed | 700 | 300 |
| Steam rollers at work | 14 | 7 |
| District surveyors (12 main road districts) | 12 | 8 |

# British Railways Under War Control

From Indian Engineer.

That the working of British railways has been a success, since at the beginning of the war they came under State control, may be taken as an accepted fact. A single control had to be established and it is difficult to see what nature of control could possibly be better than by the State with practically no change of personnel. The combination comprised a head to which under the circumstances loyal obedience was due, and a working body which had grown up under all the advantages that attach to training in a commercial concern. Accordingly when the new control became operative the working of railways passed with the greatest smoothness into its new groove It has been difficult to get at the details involved in the change, but the British Board of Trade has now summarized them in its Journal in a clear and interesting manner.

The first step taken was to appoint a railway executive committee formed out of the staffs of the railway companies, the Board of Trade working through this committee. It now consists of 18 members with a modest office. It was arranged that until the railways were taken over by Government under the Act of 1871, this committee (then consisting only of seven of the general managers of railways) should act merely as an advisory body, and should, in addition, form part of a board of communications, presided over by the quartermaster-general to the forces. Under direction by the board of communications and the railway executive committee plans had been worked out for the train services required for mobilization with a special time table for the conveyance of an expeditionary force of six divisions to Southampton. This special movement which was only one of many, necessitated at one and the same time on the outbreak of war, took 689 trains and occupied 16 days. The force consisted of 126,500 men, 354 guns, 42,000 horses, 6,000 vehicles and 5,000 tons of stores. An immense amount of general movement was being carried out in the same period, all without accident or serious delay; and this was made possible only by a wide use of the telephone. of which a large number of new circuits were at once set up. The railways were taken over under warrant at once which left all detail questions. such as compensation, etc., to be settled at leisure afterwards. When the first rush of mobilization was over the question was at once taken up. The basis recommended by the executive committee and accepted by the companies was that the compensation to be paid should be the ascertained deficiency in the aggregate net receipts of all the railways taken over, as compared with the aggregate for the corresponding period of 1913, "provided that, if the aggregate net receipts for the first half of the year 1914 are less than the aggregate net receipts for the first half of the year 1913, the ascertained deficiency shall be reduced in the same proportion." This was to cover all special services. Certain slight modifications in terms were afterwards made, one being that bonuses and "war wages" allowed to railway men were met by the Government; another was the making of allowances to the companies in respect to deferred maintenance and renewals.

The next subject dealt with is traffic difficulties and how they were met. The first trouble arose from a sudden depletion of staff by the joining up for military duty of all reservists and territorials. This was followed as early as September, 1914, by considerable volunteer enlistments on Lord Kitchener appealing to the country for men for his new army, so that in two short months a crisis seemed imminent. To meet it substitutes, male and female, began to be taken on, and it was soon found that the latter proved most efficient in every capacity they were tried—porters, ticket collectors, clerks, carriage cleaners, etc., so that they began to be employed in increasing numbers, which by the end of 1917 had reached 52,343. Then a pressing demand arose for railway workers in France and staffs had to be further depleted, although by now the practice had become established of supplying for the railways in France men released from the army with railway experience. Between August, 1914, and December, 1917, the railways in England had released 168,202 men for service with the colors, or 27 per cent of the total staff at the outbreak of the war. Naturally also car shortage became from an early period a pronounced difficulty. The ports on the East Coast had to be closed, with the result that the sea-borne traffic on that side was transferred to the railways; and at the same time, not realizing what it meant to the traffic problem, the Government authorities took to keeping cars loaded for unusual periods, as if they were store-rooms, or of sending them off in haste much under-loaded. To deal with this situation a committee had to be appointed whose inquiries and report put a stop to the practices. Against private traders at first the demurrage rules in existence began to be more strictly enforced, then there was imposed what were known as orders under the defense of the realm regulations, in December, 1916. The orders enforced the prompt unloading of cars by traders by making failure to unload in accordance with the order an offense with the prospect of a much more severe punishment than would be represented by the imposition of a demurrage penalty merely. These orders actually reduced the free time allowed and gave the railway the right when the time was exceeded of unloading the cars at the trader's expense, warehousing the goods and detaining them till all charges were paid. Other measures to facilitate movement of goods were also taken. Certain selected routes were consigned to goods traffic regardless of the fact that they might not be the most direct; and again, men of the transport workers' battalion were told off to assist in the work of loading and unloading, both in ports and leading inland industrial towns. In addition to meeting these difficulties large demands had to be met for rolling stock and permanent-way in the different war zones—France, Egypt, Salonika and Mesopotamia. Some 600 locomotives, 20,000 open cars, 3,000 covered freight cars and 200 miles of track were thus sent out of the country, necessitating the closing of many small branch lines.

The drastic regulation of passenger traffic no less than of freight traffic became a necessity. It was necessary to make room for a continuously growing movement of troops and munitions, to work with reducing rolling stock and to economize coal, so a beginning had to be made with restrictions much against the feeling of the companies. At first there was a temporary suspension of traffic on certain lines in the metropolitan area, and a reduction in some of the suburban and main-line services. Next, competitive trains were withdrawn, and later, dining and sleeping cars, and at the same time excursion fares and cheap bookings were canceled. Still later, certain stations were closed with which there were alternative means of communication; and then from Jan. 1, 1917, passenger fares were increased by 50 per cent and luggage cut down to 100 lb. per passenger. Notwithstanding all this the position in March, 1918, was that after a temporary reduction in traveling it had begun to grow again and had reached very large dimensions. The president of the board of trade then intimated that in the near future it was probable further restrictions would be established and that at once a number of passenger trains would be canceled.

The endeavor to create a general pool of cars, and to include in the pool all privately owned cars, has met with only partial success. Before the war about half the total number of cars was privately owned, built to some traders' specific purposes. In the way they were used much waste of movement occurred. For instance, a colliery company's cars would be hauled full from a coal district to the station yard of the dealer who had ordered its load of coal. It would then stand idle until unloaded, being often used as a storehouse on wheels and afterwards in leisurely fashion would drift back empty to the colliery which owned it. The abuse was patent, but there were powerful interests opposing reform, and all the board of trade found themselves able to do under the circumstances was to issue an order on March 16, 1917, providing that when a private owner's car would otherwise be sent on a journey empty, the board of trade might take possession of it for that journey and make use of it, subject to payment to the owner of hire to be agreed upon. There were many difficulties also connected with the pooling of railway cars. In the first place they were not built to a standard and certain cars were adapted to the conveyance of a certain class of goods only or to discharge at ports provided with certain types of appliances only. All that could be done therefore was to group definite classes of cars together and to make use of these as joint equipment. This meant that some 300,000 cars of a generally useful type, belonging to the controlled companies would become available for use in any direction upon all the companies' lines.

In these ways traffic has been regulated to a large extent, and though it was estimated that freight traffic on British railways last year was 60 per cent heavier than before the war, it has been successfully operated with a greatly reduced staff and much depleted stock.

## Employment of Women in Industries After the War

From a paper by Russell Sinclair, entitled "Some Notes and Observations Relative to Engineering in Great Britain During the War," published in the Proceedings, Engineering Association of New South Wales.

No question is causing more discussion in engineering circles at the present time, both in Great Britain and in Australia, than the one: What will be the scope for the employment of women after the war? No one has given a satisfactory reply, and none can be given at this time; it is quite impossible to form any definite conclusion—for one thing the war is not finished yet, and many developments will take place before it is; the employment of women is daily increasing in numbers, and in the nature of their work they are all the time proving their capabilities in work, which none ever thought they would be able to tackle, but necessity knows no law, and before the war is over we may see hardly one branch of industry left in which they will not have shown their usefulness.

I can only give an opinion based on personal observation, from which I gather that of the total number of women employed:

10 per cent are purely voluntary, actuated by war enthusiasm, who, having no need of work, will drop out as soon as the pressure relaxes.

30 per cent are women who, while having to work for their living, are normally engaged in other classes of work such as typists, shop girls, milliners, domestic servants, etc., who will return to their previous employment.

25 per cent are women who are working to help to fill the billets of their husbands, brothers or male friends, and will return to domestic duties on the return of the soldiers and the re-establishment of homes now dispersed or closed.

10 per cent are women who have been employed previous to the war in similar work, and will again be employed on their work on resumption of normal trade. This leaves

25 per cent women who, having learned engineering work, will be available for use in industrial branches of trade.

These should easily be absorbed without causing any difficulties, because there will be a great shortage of men, as many will have been incapacitated through accidents to limbs, others it is a matter of deep regret will never come back, and others yet again will not wish to take up their old work, while the great demand for labor, which is certain to be felt owing to the necessity for rebuilding the wastage in shipping, bridges, motor cars, machinery, etc., will mean for a long time to come that there will be work for all, and all the skilled men available will be required to handle skilled operations, leaving the unskilled and women labor to handle the simple operations. To me it seems the development of the employment of women is going to result in an increase of employment and demand for the skilled man at the higher wage, and the encouragement to the employer to develop the use of machinery for the greater development of the engineering enterprise of the nation.

# English Practice in Overburden Stripping in Mining Iron Ore

From Minutes Proceedings Institute of Civil Engineers

The overburden varies in depth and density of material. The depth may reach as much as 50 ft.; the density and nature of the material varies from sand up to hard clay, or even limestone itself. Generally, the minimum depth at which machinery is introduced is 12 ft., but volume of output and rate of wages paid must also be taken into account. Smaller and lighter machines are also being introduced for the shallow overburdens.

There are four general methods for dealing with overburden as follows:

By a crane or full-circle type navvy with especially long jib and bucket arm.

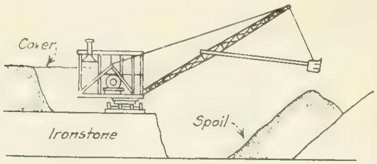


Fig. 1—Crane or Full Circle Type Navvy.

By a standard crane-navvy working with a traveling transporter.

By a combined machine—i. e., navvy and transporter combined.

By a continuous-bucket machine with extended delivery chute.

**Stripping with Long Jib-Crane Navvy**—In stripping the overburden by means of a long jib-crane navvy, the navvy travels upon the exposed ironstone, and after digging the material (of the overburden) in the orthodox navvy manner, swings round and transfers it to the far side of the workings, upon the land from which the ironstone has been removed. (Fig. 1.)

The machines comprise the framing, bedplate, engines and machinery generally, of the standard crane-navvy of 20 tons cutting pressure, to be described later, with a specially lengthened and lightened jib and bucket arm. This enables the machine to discharge the material a distance of 60 ft. measured from the center of the machine, the cutting pressure being reduced in proportion. The class of overburden upon which such a machine operates is dependent entirely upon the cutting pressure that it has available. This particular machine has a cutting pressure of about 6 tons, carrying a bucket of 1 to 1½ cu. yd. capacity, and is suitable for dealing with material ranging from sand to medium clay. The net weight of the machine is 58 tons. It is capable of removing about 400 cu. yd. per day, with two men on the machine and two around it, at an average working cost for labor, coal, oil and stores of about £2 8s. ($12) per day, or equivalent to approximately 1½d. (3 ct.) per cu. yd. Interest, depreciation and repairs will add approximately another ¾d. to this, making a total cost of about 2½d. (5 ct.) against 6d. compared with hand labor alone.

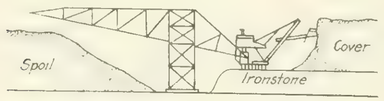


Fig. 2—Standard Crane Navvy with Traveling Transporter.

At the other end of the scale is a huge machine which will deal with heavy material, or, if necessary, easier materials in greater quantities. This has a cutting pressure of over 30 tons, carries a bucket of 6 to 8 cu. yd. capacity, and weighs upwards of 300 tons. The working speed is about two complete cycles per minute, and it is capable of handling 3,000 to 4,000 cu. yd. per day. It has a dumping radius of 100 ft. and will handle overburden 40 ft. deep.

**Standard Crane Navvy with Travelling Transporter**—The most generally useful and popular stripping plant is the second type—namely, a standard crane navvy, working in conjunction with a transporter similar to Fig. 2. Overburden of practically any nature, and in any reasonable quantity, can be dealt with, and no difficulty exists in making the transporter sufficiently long enough to carry and dump the excavated material well away from the workings. The navvy works upon the exposed surface of the ironstone, and the transporter travels upon a wider track at the base of the quarry.

The transporter is of the tower type, with extended booms carrying the track on either side. It has its power plant, consisting of vertical boiler and winding engine, on the carriage upon which the tower is built. The steel skip travels on the track of the transporter, operated by a wire rope and friction-clutch from the winding engine. When the skip is at the lower end of the track it receives each discharge from the navvy bucket, and after traveling up to the outer and mechanically discharges it over on to the ground from which the ironstone has been removed. In some cases a conveyor belt is used, but for the heavy material in which this outfit is usually worked the traveling skip is the better, as not only does the skip arrangement consist of fewer and simpler parts, but the control of the point of discharge is more readily carried out. The advantage of this is, in most cases, that the land has to be leveled and resoiled again for cultivation purposes; consequently the correct adjustment of the discharge point leaves a level surface on the dumping side and saves hand leveling. The machine is moved about the quarry and advanced, in conjunction with the navvy, under its own power.

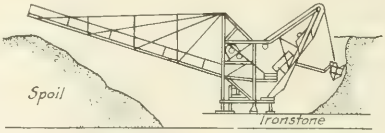


Fig. 3—Navvy and Transporter Combined.

The plans vary in size according to the nature of the material to be dealt with, but still more so for the output required. The particular machine illustrated weighs over 55 tons, the installation being suitable for dealing with overburden up to 30 ft. deep. The transporter is 130 ft. long, the skip having a capacity of 3½ cu. yd.

The working costs can be calculated as follows: three men upon the navvy, one upon the transporter and five unskilled laborers, a total of nine men. Their wages added to the cost of coal, oil, etc., will come to about £4 8s. ($22) per day, which for an output of 700 to 800 cu. yd. per day gives a cost of approximately 1.3d. (2.6 ct.) per cu. yd. Interest, depreciation and repairs will add approximately ¾d., making a total cost of approximately 2d. (4 ct.) against 7d (14 ct.) for hand labor alone. Smaller plants of this type weigh about 20, 30 and 40 tons each, for varying outputs of approximately 300, 500 and 700 cu. yd. per day.

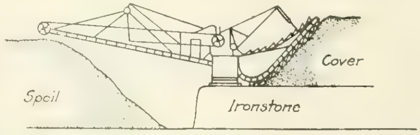


Fig. 4—Continuous Bucket Machine With Extended Delivery Chute.

**Combination Navvy and Transporter Stripping Plant**—Where the working conditions allow, the third type mentioned is used, namely, a combination navvy and transporter (See Fig. 3). Its chief advantages are that fewer men are required, and only one boiler and set of tracks are required. In such a machine the principle of the bucket-arm of the steam navvy has been incorporated with the track boom and skip of a transporter like the one just described. After the bucket has completed its cut the hoisting is continued until the bucket is over the top end of a chute built into the jib. The bucket-door catch is then automatically released and the contents of the bucket are discharged down the chute into the transporter skip. A belt conveyor may be used, but it would have the same disadvantages as previously described. The weight of the machine is 86 tons net. It carries four sets of engines, supplied with steam by one vertical boiler. One set of engines controls the digging through a steam-operated friction-clutch; a smaller set hauls the loaded skip up the track and is also connected to the traveling gear of the machine. The third set slues the jib when the bucket has cut all the material it can reach, while the fourth set, mounted inside the jib, controls the working radius of the bucket arm, to regulate the thickness of the cut and draw the bucket teeth out of the material as required.

Only two men are required upon the machine and four around it for an output of 600 to 700 cu. yd. per day. The cost of working, including coal, etc., is approximately £3 10s. 0d. ($17.50) per day, which gives a cost of 1.3d. (2.6 ct.) per cu. yd., or about 2d. (4 ct.) per cu. yd., including depreciation, interest and repairs, against 6d. (12 ct.) per cu. yd. for hand labor.

**Continuous Bucket Machine with Extended Delivery Chute**—The fourth type employing continuous bucket excavation is shown in the diagram, Fig. 4. These machines of the dredger type employ a continuous chain with buckets or scoops mounted thereon at intervals. The buckets, as they pass over, either up or down, scoop up the overburden on the way, delivering it into a chute fixed above a traveling conveyor band. The band runs out over an extended boom, delivering the spoil, at the extreme end, on to the side of the quarry that has already been cleared of ironstone. Though the discharge is fairly even, additional labor is required for leveling to render the ground again effective for agricultural purposes.

However, it is usual to employ such machines on a light sandy cover when final leveling is not necessary. The output of the dredger type machine is high, but they are also expensive in first cost; therefore their use is somewhat limited and does not obtain except in the sand cover of the Frodingham district. They are not at all suitable for heavy material, especially if any stones are present.

The power plant consists of a locomotive-type boiler with steam-engine mounted direct thereon (semi-portable type). This drives the various motions of digging, conveying, traveling, raising and lowering of bucket ladder through friction clutches and gearing. Like all the other machines for dealing with overburden it travels upon the bared surface of the ironstone.

An output of about 700 cu. yd. per day is obtained from the machine illustrated, each bucket having a capacity of 2½ cu. ft. The machines previously described have only a short length of track for working upon, just a little longer in fact than the wheelbase of the machines, but with the dredger type a long length of track laid the full length of the working face is required. The whole track is slued nearer to the face when the machine reaches the end of the cutting and after it has cut away all the material within reach. One or two men are required upon the excavator and eight or ten to move the track, although their time is not fully occupied with this work. The cost per cu. yd. of material, including interest, depreciation and repairs, is from 1½d. (3 ct.) to 2d. (4 ct.). The excavator has a continuous travel of about 6 ft. per minute, the cutting action of the bucket taking place in conjunction with it at the rate of about 40 ft. per minute. The weight of the machine is about 40 tons, and it is designed to deal with about 25 ft. of overburden. A larger but similar design of machine in the Frodingham district weighs close upon 200 tons and it is designed for a 40-ft. face, the extreme length being 300 ft.

# Post-War Reconstruction Arrangements

It is gratifying to note that a complete system has been devised for the demobilisation of the army, and it is understood that the details are arranged to meet the requirements of industry rather than to suit military exigency. It is, further, pleasing to learn that employers in industry have already signified their desire for the return to their old positions of quite 60 per cent of the men with the Colors. So that, if the arrangements of the military authorities are efficient, there should be a quick reinstatement of the fighting forces into the industrial army. This, of course, is not all that is necessary. There are one hundred and one questions to settle, principally regarding priority, and at the same time the difficulties of an adequate supply of machinery and material must be met. There are pivotal industries and pivotal men in each industry, and it is particularly important that the relative value to each industry of men and material to overcome inertia due to interruption of manufactures should be dealt with in a thoroughly organized way. * * *

The work done by the Ministry of Reconstruction, since its creation 6 months ago (August, 1917), is so far satisfactory, and, on paper, at all events, shows that all the requirements are being anticipated in a broad spirit. * * * An Advisory Council has been organized representative of all the leading interests concerned in reconstruction. * * * The reconstruction may be said to embrace almost every department of the State, and this council must therefore concern itself with a great variety of public departments. In this duplication there is grave danger of inefficiency, and to be forewarned is to be forearmed. The main considerations should be the development of the maximum of effort by private enterprise, the minimum of Government control, with the maximum of Government support and stimulus. The council is to be divided into four main sections, one dealing with commerce and production; another with finance, shipping and common service; a third with labor and industrial organizations; and a fourth with social development, including agriculture, health and housing. All of these sections will have their sub-departments.

The section dealing with commerce and production is of primary importance, and already, in connection with the supply and control of raw materials, a committee of investigation has been set up with Sir Clarendon Hyde as chairman. * * *

Another department has reference to the establishment of new industries, and a committee is already considering what can be done in this direction, so far as the engineering trade is concerned. Already a preliminary list of possible products has been prepared, and we hope that this department of the work will have full scope. The labor problem connected with such new industries is to be the subject of consideration by a special sub-committee, as will also be the volume and nature of the demand for British goods after the war. An important consideration is the organization of comprehensive trade associations for economizing production. A great change has come over official opinions regarding this matter, because it is realized that it is better in many cases to confine the individual factory to the manufacture and production of a specific type and size, leaving other factories to deal with variations of the same product of different design, finish and size. It is also realized that under such conditions economy in production can be best achieved, and the Government is therefore doing all they can to bring about such trade association, the only proviso being that they shall have some object other than the fixing of price, which is often the aim of combines. A true application of the principle of trade organization will cheapen production without affecting the earnings of the employees, and therefore facilitate the extension of British trade. In many of these operations the Ministry of Reconstruction has the co-operation not only of the Board of Trade and particularly of the Department of Overseas Trade, but also of the Ministry of Munitions, who are assisting in the collation of information from the controlled establishments. Consequently, in the opening of new markets the Department of Overseas Trade can be of immense advantage, and if they can get to work quickly and energetically they will be able to point the way along which we must go in establishing new industries, particularly for the absorption of woman labor after "the boys come home."

The Finance and Shipping Section will deal with the question of merchandise and exchange after the war, and to this section is to be relegated the very important duty of disposing of government surplus stores after the declaration of peace. It is impossible to estimate the value of these stores; they probably run into hundreds of millions sterling, and already the Department is compiling inventories of such stores for the service of the Committee. At the same time public bodies like county councils, road departments, and the Governments of the Dominions, are being consulted as to their possible requirements, so that there will be available, before the stores are liberated, some data on which to proceed in their disposal. In the words of the Department, the first object is "to protect the taxpayer from improvident selling; the second is to protect the markets, and therefore labor, from the dislocation which will inevitably result, if, for instance, some hundreds of thousands of motor vehicles were released for sale at once." The executive arrangements are being passed on to a specially created body, which will be composed of men of much experience in such work. The Advisory Council will lay down certain lines for their guidance.

The Labor Section of the Council must necessarily work in concert with the Ministry of Labor, and here there is danger of overlapping and unnecessary interference. The main item, however, so far as reconstruction is concerned, is the establishment of industrial councils on the lines of the Whitley Report. * * * This section, too, is dealing with the question of labor in merchant shipping, the war time departures from trade union practices, industrial courts, industrial structures and apprenticeship. It will, moreover, be concerned with the question of demobilization and the absorption of service labor after the war for the prosecution of public works and the rectification of the relation between men and women workers. As to the section dealing with social arrangements little need here be said, but the question of housing arrangements, now far advanced, concerns the simplification of building by-laws, as well as of material for the construction of houses. * * *

## Possibilities of Municipal Salvage of Refuse

In a paper presented at a recent meeting of the Institute of Street Cleaning Superintendents, David Currie, Director General of National Salvage of England, estimated the quantity of refuse made annually throughout England at 9,450,000 tons. This figure is based on allowance of 1,680 lb. per 1,000 population during 300 days of the year. To determine the nature and composition of this material a careful analysis of bulk lots of ordinary refuse such as could have been passed in due course through the destructor was made by the authorities of Accrington, Bury, Hackney and Sheffield.

The following table shows the average results, and what they represent, according to Mr. Currie, may be applied to the refuse of the country generally:

ANALYSIS OF "REFUSE"

| Commodity | Analysis of refuse in Sheffield, Accrington, Hackney and Bury. Per cent. | Applied to population Great Britain, assuming 15 cwt. per 1,000 population per day during 300 days annually = 9,450,000 tons. Tons. |
|---|---|---|
| Fine dust | [illegible] | 4,800,000 |
| Cinders | 39.63 | 3,700,000 |
| Bricks, pots, shales, etc.... | [illegible] | 500,000 |
| Tins | [illegible] | 90,000 |
| [illegible] | [illegible] | 50,000 |
| Glass | [illegible] | 50,000 |
| Bones | 0.05 | 4,000 |
| Vegetable matter.......... | [illegible] | 68,000 |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | 7,000 |
| [illegible] | [illegible] | 58,000 |

## Pneumatic Riveting in British Shipyards

From The Engineer.

It is common knowledge that the present rate of output of merchant shipping falls far short of what is necessary and possible. Even if the two most obvious causes of this, viz.: shortage of skilled labor and bad time-keeping, were removed, the output would still remain far below what is easily possible. One of the principle reasons for this is simply that British shipyards make very little use of pneumatic tools. To what extent the capacity of shipyards may be affected by the use of pneumatic riveting instead of hand riveting, the following figures will show. According to information recently received from one of the East Coast shipyards, the best day's work on a shell with pneumatic riveting is 700 rivets of ⅞-in. diameter, and for hand work under the same conditions 430 rivets. An average day's work, however, is considerably less than this, and may be taken as being 510 rivets with pneumatic riveters as against 264 with a hand squad, the figures being taken for work on all parts of one ship. The number of rivets driven per day by a riveting squad varies, of course, according to the part of the ship worked upon and the size of rivet used. The following may be taken as indicating the difference in one day's work of a hand and pneumatic riveting squad: On the shell with ⅞-in. rivets, hand riveting, 260 to 360 rivets, with pneumatic riveting, 500 to 550; on the deck, with ⅝-in. rivets, hand riveting, 450, pneumatic 700; on the deck with ¾-in. and ⅞-in. rivets, hand riveting 350, pneumatic 550.

The greatly increased output of work secured by the pneumatic tool is in itself sufficient to establish its very considerable superiority over the hand method. But it has another very important advantage. A hand-riveting squad consists of three men and one or two boys. From two of these squads, three pneumatic riveting squads can be formed, thus effecting a saving of 50 per cent in labor alone. A third advantage claimed for the pneumatic tool is that it gives both the other advantages with less exertion and consequently less fatigue on the part of the men.

With these advantages to its credit, it is, nevertheless, the fact that the pneumatic tool is greatly neglected in British shipyards, as the following facts and figures, taken from the returns of 70 of the leading yards of the country, will show. Only yards having berths of over 250 ft. in length are taken. It may be said in passing, that the equipment necessary for the efficient working of a berth is generally considered to consist of a compressor plant of 1,000 cu. ft. per minute capacity, to supply the compressed air for driving the tools, and 60 pneumatic tools of which 20 should be riveting hammers.

Taking the 10 best-equipped yards in the country, they have, as a rule, compressor plants of 1,000 cu. ft. per minute per berth, but only 52 pneumatic tools, of which only 1½—on the average—instead of 20 are riveting hammers. The average of the remaining 60 yards is much below even this standard. It shows only 21 tools per berth. Moreover, only about ⅓ of the number of riveting hammers in stock in the yards are actually used. Then again, there are 22 important yards in the country, with a total of 77 berths, which have no pneumatic plant whatever. Shortage of riveters is, beyond question, one of the chief causes, or the chief cause of the deficient output at the present moment. This shortage is no new thing in the British yards, where for the last 8 or 10 years the supply of riveters has fallen short of the demand. War and other causes have further reduced their number, while the volume of work has been increased. The serious effect of this state of affairs on the output of ships must be obvious. In some yards, ships completely plated cannt be launched because they cannot be riveted. The solution of the problem is to be found to a very great extent in the greatest possible use of the pneumatic tool. The United States yards, by its almost universal employment of pneumatic riveting tools, has been able to overcome its shortage of skilled labor.

# Method of Strengthening the Tongabuddra Bridge of Madras Railway

From Indian Engineer

The Tongabuddra Bridge, situated 334 miles from Madras, and 11 miles from Raichur is the longest bridge between Madras and Raichur. It was formed originally of 58-64-ft. openings with stone masonry piers founded on rock 70 ft. from center to center. These were spanned by plate girders 139 ft. 10 in. long, 4 ft. deep, placed 8 ft. apart, continuous over two spans; the roadway being formed of teak sleepers 12 ft. by 12 in. by 6 in., bolted to their top flanges, to which were spiked cast iron chairs in which were keyed 75 lb. double-headed rails.

Under the new rules for calculating the strength of railway girders, those of this bridge were found to be below the standard required. The necessary strengthening of this bridge was done by converting 8 land spans at the south end, and 14 at the north end, each into two masonry arch openings by the insertion of a central pier, the remaining deep river spans being covered by new and strong steel plate girders, each 69 ft. 10 in. long, weighing 33.75 tons per set with bracings; or nearly double the weights of the continuous girders 139 ft. 10 in. long which they replaced, these weighing 38.41 tons only.

The work was carried out as follows without interrupting traffic:

The old girders with their permanent way were first slewed between trains to the unoccupied double line side of the piers, which are 29 ft. long, after which the new piers and arches over the land spans were built to carry a single line only, and the cross sleeper chair road laid over these. The new steel girders, which were erected and riveted up on the level ground at the Tongabuddra station, about a quarter of a mile from the bridge, were then moved and put in place as follows:

Each of the pair of girders was placed on a pair of trucks with 4 low 18-in. diameter wheels, which stood in a lay-bye. At once, after the first train passed at 9 a. m. these were drawn by men over and along the existing railway of the old bridge, opposite the opening they were to span. On the vacant half of the piers, at each end of the opening the girder was to span, was made a stack of sleepers, of height sufficient to bring their top level with the truck floor; cross sleepers being laid on blocks on other sleepers fixed to the bridge girders, from and level with the track floor to the sleeper stacks. The girder ends were then slung to a cross timber supported at each end of a travelling crane, and by means of these four cranes, two for each end, the girder was moved across into position on the sleeper staging. The above process occupied well under two hours, the quickest time being 50 minutes; the second girder of the pair was taken out and got over in the same way between 1 o'clock and 3 o'clock, the intervals between other trains, the remainder of the day being spent in lowering the girders onto their bearing blocks, made of 1 part Portland cement to 2 parts sand. The sleeper staging as taken down was moved and re-erected on the piers of the next span. The cross bracing frames, and the top and bottom diagonal horizontal bracing bars were then put in place, service bolted, and riveted up; after which the cross sleepers of track, 12 ft. x 12 in. x 6 in., were bolted to the top flanges of the girders, and the chairs and rails for 5 ft. 6 in. gage line laid.

**Method Employed in Erecting Original 139-ft. 10 in. Continuous Girders, and in Removing Them After Completion of Strengthening the Bridge.**—After the new bridge was opened, the old continuous girders were rolled from their places to the bank behind each abutment, which had been previously cut down to top of pier level to receive them.

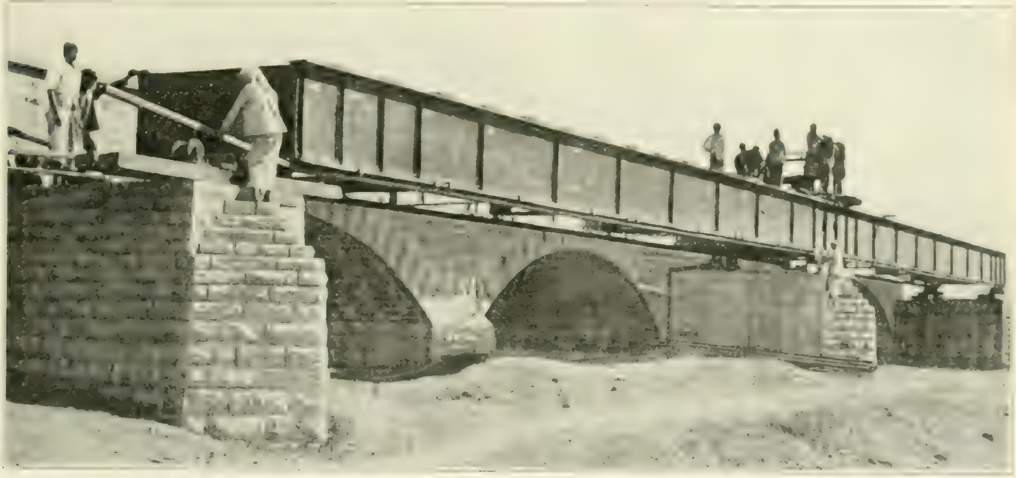


Fig. 1—Rolling Off Old Continuous Girder—Position at Starting or Landing. View Also Shows Old 64-Ft. Land Spans Converted to Two Arches.

To allow of the rapid erection of these girders, the bank behind each abutment was made level with the top of these, and on this the ordinary permanent-way sleepers were laid; the girders were then put up on these four sets to span eight openings at a time, service bolted and riveted; and as each was finished it was lifted by jacks high enough to allow old 20-ft. 75-lb. double-headed rails to be laid on them flat, packed in their web with hard wood strips, and secured to the lower flanges of the girders by hook bolts and straps, the packing being varied in thickness to conform to extra plates, covers, etc., to form a level bearing for the rails—a fishplate with countersunk bolts being used at each rail joint. The rails were allowed to project at each end, so as to take a bearing on the rollers before landing on a pier and raise the girder's overhanging end from its deflected position. Over the center of the girders a platform of sleepers bolted to the top flange was made and on this a crab winch was bolted. Four cast iron rollers in pairs spiked to sleepers were laid on each pier top to be crossed, as shown, these being spaced 8 ft. apart from center to center transversely, so that the rails fixed to the bottom flanges came on them from the [illegible] a pair of double blocks, one fixed to the front end of the girder, and the other to a pier over 6 spans ahead, or as far as the length of rope in use allowed. The girder was then rolled forward by 6 to 8 men working the winch, as may be seen in Fig. 1. When the girder reached its final place a screw jack was placed under each end, the rails used for rolling removed for use on another set, and the girders lowered on to their bearing plates.

This method, used on the old Madras Ry. for the very numerous large bridges on that railway, of 64-ft. spans, 70-ft. centers spanned by plate girders 4 ft. deep and 139 ft. 10 in. long continuous over two openings, proved most convenient, expeditious and economical as:

(a) The girders could be set up and rivetted behind the abutments, so that all the work could be done, and the rivets tested and inspected from the ground, without the use of staging.

(b) When rivetted the girders could be quickly and cheaply rolled into position, irrespective of flood or water in the rivers they crossed; without the use of staging or false works of any sort, an advantage engineers will not be slow to appreciate.

The girders of the original Tongabuddra Bridge covering 38 spans 70-ft. centers, which required 76,100 rivets in their erection, were put up, rivetted and rolled into place, by the writer in 1870, in four months—6 to 8 spans a day were rolled over.

When strengthening the Cauvery Bridge, 24 spans of 64-ft. with masonry piers 6 ft. thick at top, 70 ft. from center to center, by putting new and strong continuous girders on the double line side of the piers, the writer who was then District Engineer of the Division this was on, paid by contract, for the labor of unloading the girder materials from railway wagons, erecting, rivetting, complete Rs. 360 per set; 2 spans or Rs. 180 per span—a very cheap rate.

The girders complete weighed 55¾ tons, or, say, 28 tons per span. There were 2,808 ⅞-in. rivets in each span, the work was done without interruption to traffic. The old girders were rolled off to the abutments, cut up at the joints, and loaded into railway wagons for Rs. 100 per set, or Rs. 50 per span, by contract.

## Microphotographs of Growths in Water

Studies of the resistance to filtration of various samples of water have been conducted for many years by Dr. A. C. Houston, Director of Water Examination of the Metropolitan Water Board of London. For the last 3 years his experiments in this connection have been systematized. A further advance in these studies is noted in his last annual report. This consists in the adoption of the novel procedure of microphotographing the growths in water, thus obtaining a permanent quantitative and qualitative record of what actually took place in the water. The report, referred to above, contains 224 half-tone reproductions of photographs thus obtained.

**Reinforced Concrete Sewer Siphons at The Hague.**—The sewers of the political capital of the Netherlands, The Hague, are, after purification, discharged into the North Sea near Scheveningen. As the many canals of the district cut into the level of the underground water, the conduit has had to be laid with several up-gradients. Under those conditions the maintenance of the drainage flow required either the application of pressure or the use of siphons. During the recent improvements of the drainage, states Engineering, siphons, 2 m. in diameter, of ferro-concrete, were adopted. A cylindrical shell of sheet iron was embedded in the concrete. This shell has a thickness of 1.5 mm.; the joints are covered by strips and welded to them; the conduit was laid in sections of 4 m. length, which overlap by about 20 cm.; expansion joints are provided at distances of 250 m. The whole concrete conduit has a length of 2 km. The concrete layer inside the shell has a thickness of 17 cm., the thickness of the outer layer is 3 cm.; rings and spirals of iron are further embedded in the concrete to increase its strength.

## Principles of Sewage Irrigation

By JAMES CRAIG.

From a paper presented before Association of Managers of Sewage Disposal Works.

**Selection of Site for Sewage Irrigation Farm.**—In choosing a site for sewage irrigation the nature of the surface and subsoil is of great importance. An ideal formation would be a gravelly loam overlapping a coarse, gravelly subsoil; indeed, unless a sufficient area with means for extension to something approaching this type of land can be secured within reasonable distance of and altitude to the town and stream, other methods should be considered. Any land having impervious strata or clay formations within 3½ ft. of the surface should be completely avoided for irrigation purposes.

The nearer the site can resemble a slightly inclined plane, the better; but while an undulating surface is more costly to lay out and requires greater cost and skill to irrigate, the general principle of avoiding the path of least resistance in actually applying the sewage to the land holds good on most treatment areas.

The sewage should be delivered at a point of the irrigation area from which it can diverge by gravitation to the whole area and prospective extension areas. It will be found most convenient to have the system of distribution arranged so that the rate of flow per acre can be varied, enabling large or small sections of the area to be irrigated or rested as desired.

**Channels for Conveying Sewage.**—The conveying channels may be made of a variety of materials such as wooden or metal troughs, concrete channels, earthen channels, stoneware pipes, concrete tubes, cast-iron pipes, etc. These may be laid above or below ground, but the author considers that glazed stoneware pipes or concrete tubes thoroughly jointed and sufficiently underground to be protected from climatic influences answer the purpose admirably. Of course other carriers than main arteries may be advantageously formed in the soil itself unless a valley has to be crossed, when pipes laid on the syphonage principle would have to be resorted to in preference to carrying the liquor overhead in open or closed channels.

**Distribution of Sewage on Land.**—The distribution of the sewage onto the land requires careful attention. With arable land the ordinary ridge and furrow method of distribution gives very good results as long as the sewage is allowed a fair velocity for 4 ft. or 5 ft. after entering the furrow. Then the velocity should be checked by means of small baffles made from the soil at distances apart to suit the gradient of the section being irrigated. These baffles can be made by spade or shovel, or an arrangement can be fixed on the ordinary horse hoe to do the work more expeditiously. Five-feet baulks are also suitable for arable land. Grass land and other broadcast-sown crops may be laid out with slight furrows further apart, but at distances and altitudes to ensure quick and thorough saturation of the surface.

In most grades of irrigation land it will be found beneficial to the production and maintenance of a good effluent to have the underground drains laid parallel in preference to what is known as the "herring-bone" or lateral principle, and in the application of the sewage to the surface it should be conveyed, so far as is practicable, in a direction parallel to the underground system of drainage. Crossing over the line of an underground drain with furrows conveying sewage should be avoided, as this often causes percolation of polluted water directly to the drains and the polluting of an otherwise good effluent. Distribution is greatly aided by regular loosening of the surface of the ground; if it is allowed to form a crust, absorption is retarded, the sewage takes the path of least resistance and ponds in the lower places with often disastrous results as well as aerial and aqueous pollution.

**Drains for Effluent.**—For underground drains for drawing off effluent the author is of opinion that these should be of an average depth of 4½ ft. with a gradient of at least 1 in 1,000, and glazed socketed stoneware pipe drains laid parallel to each other and discharging into an intercepting drain which should be cement jointed with an effluent inspection chamber for each independent section of the land. The individual pipes of the collecting drains should be laid so that the spigot end only enters about half way into the socket—not forced tight up, as is done by many drainers with the back of the spade.

The trenches should be excavated sufficiently wide at the bottom to admit of 4 in. to 5 in. width of screened gravel or other clean, hard media being placed along each side of the pipes and over the top of the pipes to a depth of 12 in., then placing new-cut turf inverted over the gravel or a thin layer of straw or fine brushwood to arrest the fine particles before getting to the pipe. The trenches require to be carefully filled and rammed. In running sand it would be found advisable to supplement this by placing a layer of fine brushwood in the trench before laying the pipes to prevent the fine particles getting into the pipes from underneath and filling them up.

The sewage should be subjected to sedimentation in tanks prior to irrigation and the sludge removed from the tanks into storage lagoons until such time as the land is void of crops, when it can be carted, spread, and plowed under preparatory to planting subsequent crops.

## Large Land Reclamation Pumping Stations in Holland

From The Engineer.

Owing to the war and the consequent great diminution in food imports, the situation in Holland is becoming very grave, and serious attention is being given to the question of increasing the production of the land. Home-grown produce cannot satisfy the present demand. A large movement has been made to reclaim as much as possible of the land not in full cultivation, the first results of which are the construction of the two large pumping stations about which it is proposed to give a few details.

These two stations are situated in the Provinces of Friesland and Over-Ijssel, where they will drain the rich polders, which cannot be properly cultivated at present, owing to the bad natural drainage in autumn and spring.

The first station is at Tacozijl, near Lemmer. This installation is still (August, 1918), under construction, and when complete will consist of four compound steam engines, each of 500 I.H.P., and each driving two centrifugal pumps, which will deliver 110,170 gal. per minute; making a total of 440,680 gal. per minute for the whole station. Steam will be generated in six boilers of the Piedboeuf type, with a combined heating surface with superheaters of 3,390 sq. ft. Surface condensers will be used, and two distillers will supply the pure water. Economizers will also be fitted. The engine room measures 62 m. by 15 m. and the boiler room 31 m. by 16 m. The whole installation will be electrically lighted.

The second station is in the north of the Province of Over-Ijssel, and another type of pump is to be used. In this case the boiler battery, with economizers and superheaters, will have a heating surface of 4,040 sq. ft., and two uniflow engines, each of 600 I.H.P., will drive two pumps, direct couples, delivering together between 352,000 and 396,000 gal. per minute. Screw pumps will be used.

The complete installation in Friesland is being delivered by Louis Smulders, of Utrecht, and the second by Werkspoor of Amsterdam.

**15 [illegible] of Members of British Water Works Association in War Service.**—In his annual report submitted June 22, 1917, F. W. McCullough, President of the Institution of Water Engineers, formerly the British Association of Water Works Engineers, stated that the membership on Dec. 31, 1916, was 412, a decrease of 13 over the previous year and of 16 over 1914. Of the 412, 64 were in active army service abroad or national service at home. The net loss of 3 per cent in 1916, due to the war, he stated, was probably as small as that experienced by any other institution of the kind.

## The Setting Process in Lime Mortars and Portland Cements

[illegible]

By CECIL H. DESCH.

The hardening of a simple lime mortar, composed only of slaked lime and sand with water, is a mere process of desiccation. The calcium hydroxide forms an apparently structureless mass, which may be either colloidal or minutely crystalline, and the cohesion of this mass furnished the necessary strength. The sand merely prevents the cracking which would otherwise take place during the contraction on drying, by sub-dividing the lime into thin layers. As time goes on the calcium hydroxide may recrystallize to a certain extent, while those portions of the mass which come into contact with the atmosphere may be converted into the crystalline carbonate, but neither of these changes is essential to the hardening of the cement. There is no chemical reaction between the lime and the sand. On the other hand, when pozzolanic substances are added to the mortar, such as the volcanic earths of the Mediterranean which were used by the Greeks and Romans, the trass and ground tiles which were employed by the Romans in the more northern regions, or the burnt brick and ballast added to this day in India, a chemical reaction takes place between the lime and the active or soluble silica which is the essential constituent of all pozzolanic materials, and calcium metasilicate is formed.

Portland cement is a more complex material. The constitution of the clinker has been established by the brilliant investigations of the Geophysical Laboratory staff at Washington. The compounds which are or may present at Washington. The compounds which are or may be present are tricalcium silicate, $3CaO.SiO_2$; calcium orthosilicate, $2CaO.SiO_2$; tricalcium aluminate, $3CaO.Al_2O_3$; pentacalcium trialuminate, $5CaO.3Al_2O_3$; and free lime, CaO. Campbell has recently given reasons for believing that tricalcium aluminate is rather to be regarded as a solid solution of lime in the pentacalcium trialuminate, but this does not materially affect the present problem. Not more than three of the above-mentioned compounds can be simultaneously present in the clinker in a state of equilibrium, but since the components do not reach the temperature of fusion during the process of manufacture, it is actually possible for small quantities of one or more additional constituents to occur in commercial clinker. It does not appear, however, that slinker made in a rotary kiln departs very widely from the state of equilibrium.

An examination of the ternary equilibrium diagram shows that the clinker will contain a ternary eutectic, there being two such eutectics within the usual range of the composition of clinker. The microscopical examination of transparent sections of clinker does not reveal the presence of any eutectic, but this is simply due to the minuteness of the structure, much overlapping occurring even within the thickness of a thin section. When, however, the specimen is polished on one surface only and lightly etched, as in the examination of metals, the eutectic structure is clearly revealed. The writer has published one such photograph, and Mr. T. Hattori, working in the writer's laboratory, has since obtained very beautiful eutectic structure of Japanese clinker. The calcium aluminate which is chiefly present as a constitutent of this eutectic is consequently in a finely divided form, and therefore in a condition to react readily with water.

According to the explanation of the setting process put forward by Le Chatelier in 1887 the ground cement reacts with water in such a way that the silicates and aluminates are hydrolysed, the staple compounds being the hydrated metasiliate, $CaSiO_3.2.5H_2O$, and a hydrated tetracalcium aluminate, $4CaO.Al_2O_3.12H_2O$, the excess of lime liberated by the hydrolysis forming calcium hydroxide. Microscopical examination of the reactions of the constituents with water led to the conclusion that the process was strictly analogous with that of the setting of plaster, an unstable supersaturated solution of the basic silicate, for example, being formed initially, followed by rapid crystallization of the stable phase in the form of radiating needles. In reference to this it should be remarked that the process is largely dependent on the ratio between solid and water, and that in hydration experiments on a microscope slide the quantity of water used is relatively much larger than in the gaging of cement in practice, and that this fact probably accounts for certain discrepancies recorded by different observers.

The alternative hypothesis was proposed by W. Michaelis in 1893, and expanded in a later paper. On this view, while the chemical reactions assumed are those which were shown to take place by Le Chatelier, the physical conditions are supposed to be different. The hydrated metasilicate is considered to form, not a mass of radiating crystals, but a gelatinous mass or gel, the gradual dehydration of which brings about the hardening of the cement with time. The aluminate crystallizes much more readily than the silicate; but even this is regarded as forming a gel when the solution is sufficiently supersaturated—that is, when the quantity of water is small, as in the case in the practical utilization of cement.

The presence of gelatinous material at an early stage of the setting process is readily observed. It has been photographed by Stern, and the increase of size of the cement particles by absorption of water and consequent swelling of the gelatinous sheath which forms around them has been described by Ambronn, and may be readily confirmed. According to Colony, a reaction subsequently takes place between this early gelatinous material and the remaining constituents of the cement, and a secondary amorphous product is formed, the desiccation of which is the cause of the hardening. At a later stage crystals of calcium hyroxide, calcite, and zeolites make their appearance.

An attempt to distinguish between the various possible colloidal products has been made by Keisermann, using the method of staining with organic dyes. The results indicate that the gelatinous sheath consists of calcium metasilicates, which compound also occurs in the form of small needles, while the calcine hydroxide and aluminate assume the crystalline form. These staining results with colloids depend largely on the concentrations of the substances concerned, and the writer, possibly not working under precisely similar conditions, has not succeeded in confirming all of Keisermann's results. The dependence of the observations of the size of grain has been pointed out by Wetzel. Other experiments in which stains were used led Blumenthal to the conclusion that the metasilicate and aluminate were first formed in a crystalline condition so that the cement sat like plaster, but that a colloidal gelatinous silicate was subsequently formed, and strengthened the mass by binding the crystals together and filling the pores.

The process of setting of the individual constituents, as well as of commercial clinker and artificial mixtures, has been examined in great detail in the laboratories of the U. S. Bureau of Standards. The staining method has been applied as a means of identification, and the hydration has been followed under various conditions of temperature and proportion of water. The general conclusion is that the initial set is due to the hydration of the aluminates, and that the only stable hydrated aluminate is the tricalcium salt, the water content of which is variable. Either the 5.3 compound or monocalcium aluminate, if present, undergoes hydrolysis, and the tricalcium salt is formed together with free alumina, the latter separating in a colloidal hydrate form. In presence of an excess of water the product may be crystalline, as in Le Chatelier's original experiments, but with a restricted supply of water an impervious layer of the amorphous material may be formed, retarding the further action of water. The silicates are hydrated much more slowly, the products being calcium hydroxide and an amorphous jelly of hydrated silicate. The hydroxide may be crystalline or amorphous, according to the concentration and to the rate of hydration. The hydrolysis of the silicates is even considered to proceed so far that gelatinous silica is liberated. The subsequent conversion of a part of the gelatinous mass into crystals is considered to result rather in a loss than in a gain of strength.

It would appear that conclusions based on the examination of mixtures of ground material with water on a microscope slide must not be applied indiscriminately to the conditions of actual practice. The ratio of water to salts is of the utmost importance in determining the nature of the products, although the chemical reactions may be the same in both cases. An attempt has been made by Von Weimarn to show that the passage from the colloidal to the crystalline condition is a continuous one, and that the difference consists only in a difference of size of the particles. This may be accepted in the sense of considering colloidal materials as being in such a fine state of division that the surface forces are comparable in their effect with those which depend on mass. It is then not difficult to understand that the degree of supersaturation of the solution may determine whether the product which separates shall have a definite crystalline form or shall be in the ordinary sense amorphous. The real nature of the colloidal condition has been unnecessarily obscured by the barbarous terminology which has been adopted by so many writers on the chemistry of colloids, and especially by the school of W. Ostwald.

A final reference should be made to the action of catalysts on the process of setting. The subject has not been sufficiently investigated, and affords a promising field for research.

## The Effects of the War on British Industries

Before the war the Hadfield Works at Sheffield employed 6,000 men and was content to leave many valuable fields to Germany. Now the company employs 15,000 men and is manufacturing everything it formerly obtained from Germany. Commenting on the changes brought about by the war, Sir Robert Hadfield, president of the company, is quoted in the London Observer as stating that after the war ends industrial England will be 50 per cent. more efficient than when the war began, and this despite the absence of the many workers whom the war will have destroyed. English employers generally, he said, are learning the lessons which some Americans learned long ago. "At our plants," he added, "we have reduced working hours, with that largely beneficial result which seems to be inevitable. We find that shorter hours make good men better and bring the medium workman up to something higher than the old-time average. As some of us look back over recent industrial history, the fact becomes apparent that in the pre-war days, we in England were very skilful in our efforts to impede our own progress. On one side the employers, and on the other side the men, devoted vast vital energy to the creation of great combines, each devised as if for the purpose of preventing its side from advancing. Had not Germany forced war upon us we might have had good reason to fear for the future. For years our employers had made an earnest and successful fight against the forty-eight hour week. Now, under war conditions, when it is necessary that we should produce at a maximum, we have turned to it as a means to just that end and find it most efficient. The hostility of the men to various progressive things was as unfailing as, for instance, their opposition to labor-saving machinery. Now they have learned that the better the tools the better the workman, and that the better the workman the better his pay. An intelligent workman should have more self-respect than is indicated by willingness to do labor which a machine could do as well. In England workers only now are beginning to realize this. The fact that workmen are not themselves machines is not yet appreciated at its full value even in America, for if workers should be too proud to rank themselves as machinery, employers should be too wise thus to rank them. All employers have been doing so."

# Design and Construction Features of Reinforced Concrete Vessels

By WALTER POLLOCK, M. Inst. Naval Architects.

Abstract in The Engineer of a paper presented in March, 1918, before the Institution of Naval Architects.

**Ideal Points Aimed At.**—Designers and builders are striving to produce a reinforced concrete vessel: (1) That will as nearly as possible reduce the weight of the hull to that of a steel ship of the same deadweight capacity; (2) that will contain not more than one-quarter of one-fifth of the steel that is required in a steel ship; (3) that will be sufficiently strong and safe with a thin concrete hull to stand stresses and ordinary knocks, and at the same time have the necessary density to ensure watertightness, (4) with a concrete that will not fracture by expansion and contraction, and that can be protected from disintegration in contact with acids, etc.; (5) That can be launched quickly after completion, without danger to the concrete work; (6) That after bottom and side damage has been repaired, can be put to work again quickly without waiting several weeks for the repair work to set and harden.

**Consideration of Design.**—The underlying principles are to use only the amount of steel necessary to take up the tensile stresses and for the concrete to do the rest and stiffen the structure. The "web" of the transverse section of a steel ship—that is, the connection of the deck and bottom plating—required a considerable weight of steel plates which in the reinforced concrete vessels is mostly substituted by concrete. From the naval architect's point of view there are no great difficulties in this design and construction of these vessels. River vessels have to provide only for ordinary hydrostatic pressures, except where they have to ground on an uneven bottom, and the shocks and stresses due to coming in contact with other vessels, quay walls, etc. Sea-going vessels have to provide for dynamic forces due to mooring, berthing, docking, etc., as well as sagging, hogging, and torsional strains when striking or falling in a heavy sea. The vibration of a ship in ballast after striking a wave may be found one of the most serious problems in concrete ships. The bending and hogging strains due to wave conditions can be readily calculated, but the torsional and racking strains cannot. Shallow-draft and river vessels, having as a rule only the strains due to unequal loading, grounding, etc., thus allow the scantlings to be lighter than is necessary for sea-going vessels.

The ideal design would appear to be a vessel with longitudinal construction—dispensing with two-thirds of the usual floors and frames—fitting only a few web-frames and as many bulkheads as possible, and, in addition to the usual longitudinal rods, a series of diagonal ones. In larger size vessels it would no doubt be advisable to fit a center bulkhead for the full length of the ship; but in any case it is advisable for cargo vessels to have the hatch coamings continuous all fore and aft, as shown in Fig. 1. In smaller vessels a continuous earling, even if it projects 6 in. above the deck, is desirable. The calculations are in general similar to those of a steel ship. A set of curves of bending moments and shearing forces for a 300-ton deadweight vessel are given in Figs. 4 and 5.

It is not difficult to design a reinforced concrete vessel with graceful form, nice curved lines and a handsome sheer though difficulty and expense are involved in building and in keeping the steel reinforcement in place during molding and casting. To overcome these difficulties, the author designed the "straight-lined" vessels in July, 1917, and published a number of designs wherein all the transverse sections are straight lines throughout the ship, the sheer being also in straight lines. The central portion of the ship for more than two-thirds of the length is rectangular except for the angle of the bilge, which forms a double chine (See Fig. 3 and Fig. 7).

If the steel reinforcement is not kept in its proper position both vertically and horizontally in the thin slab walls of the shell, bulkheads, hatch coamings, bulwarks, casings, etc., a considerable amount of the strength of the reinforced concrete structure will be sacrificed. Take for an example a 3-in. slab curved vertically, horizontally, and diagonally, as is the case on the bow of an ordinary ship-shaped vessel. It is almost impossible to keep all the steel work in its proper position, and a deviation of only ¼ in. of the bars one side will bring them so close to the surface as probably to throw off the concrete, or if not inwards will considerably reduce the strength of the slav locally. Furthermore, if the steel rods be not true to line, they tend to straighten out when subject to a tensile pull and cause the concrete to burst off, besides reducing their effectiveness by introducing secondary stresses.

Fig 1

GENERAL ARRANGEMENT REINFORCED CONCRETE COASTER

125 0 B P • 25 0 • 11 9 MLD 120 B H P M TYPE ENGINE

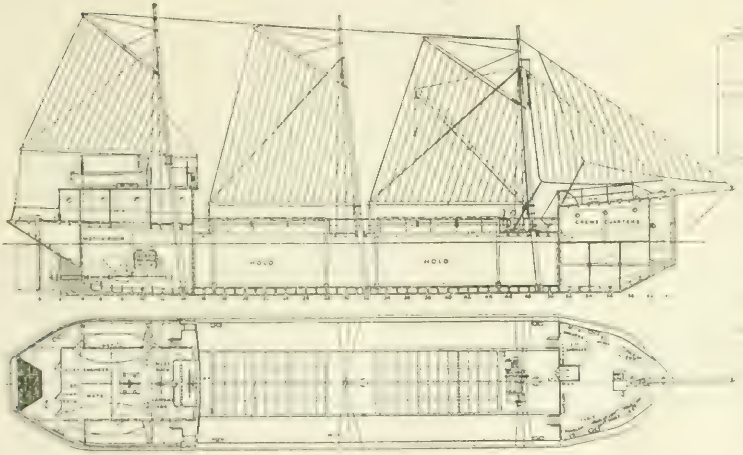


Fig 2

PATENT STERN FRAME

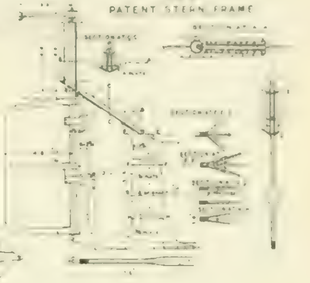
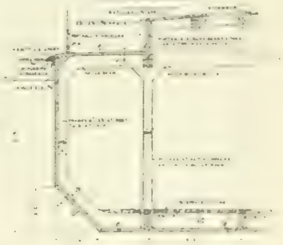


Fig 3

MIDSHIP SECTION



The unit method of construction is being tried, but the advantages for ship work have yet to be proved, while the disadvantages are serious; so that the monolithic system, which makes it easy to obtain continuity of strength, is almost universally used. For small vessels, barges, etc., a slab form of construction (Fig. 10) should be much more economical, as it dispenses entirely with floors and frames, side keelsons, stringers, beams, etc. The forms being reduced to a minimum, are quickly placed in position and more rapid construction attained. Bulwarks and hatch coamings are difficult to design for avoiding damage whilst loading or discharging cargo. The former can therefore be dispensed with and hinged stanchions and lifelines substituted, especially if the hatch coaming is made continuous. The latter should have a strong top and rest bar to avoid damage (See Fig. 9).

Fenders are necessary for all concrete vessels to protect the concrete, but in an experimental barge of 130 tons deadweight capacity, fenders have been entirely dispensed with on the advice of the concrete designer, the corners of the gunwale being well rounded and finished off with a mortar of one of cement to one of sand, so as to avoid being chipped when coming in contact with or striking other barges. A solid half-round for the gunwale, as shown on Fig. 10, and other chafing irons are desirable and may prove an advantage. It would be advisable to fit fenders to all vessels as a precautionary measure, at least for the present, following the usual method of fitting close against the concrete work instead of a few inches off the shell with wood chocks in way of the bolts. A fender at the bilge, as shown on Fig. 9, will protect the concrete and at the same time act as a bilge keel. All edges or corners throughout the vessel should be rounded or beveled where possible to prevent being chipped or broken off. If the concrete is subject to considerable rubbing or chafing it will wear away.

FIG 4

CREST OF WAVE

1300 FT TONS MAX BENDING MOMENT (HOGGING)

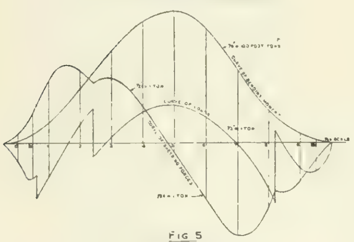


FIG 5

HOLLOW OF WAVE

1230 FT TONS MAX BENDING MOMENT (SAGGING)

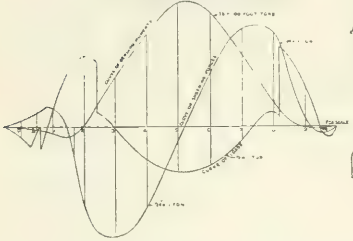


FIG 6

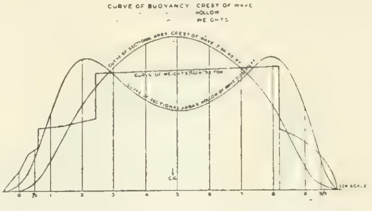
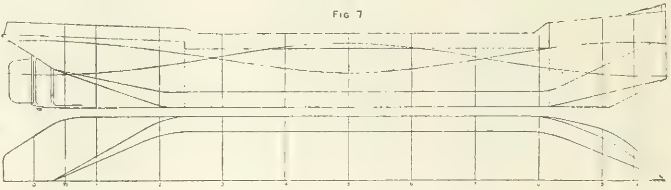


FIG 7



There are the following methods of reinforcements: (a) Wire netting, expanding metal, and similar mesh work with or without bars. (b) Flat bars, special bars, steel joints, etc. (c) Round bars of varying diameters.

All these are suitable for either the unit method or monolithic method of construction, and may be used either singly or in combination.

The wire netting and expanded metal is not likely to be adopted for the shell work of sea-going vessels, because of the difficulty in keeping it true to line and obtaining homogeneity, as well as its excessive cost and the difficulty in the varying net work sufficiently to suit the stresses. Various sections other than round bars have been adopted in a number of cases, especially in America, but no doubt the round bars will be generally adopted, because they utilize the steel without waste, are easy to arrange in position, easier to bend, more readily obtainable, and adapt themselves to a minimum quantity of concrete. Some claim that mechanical bond bars—to which kind all special bars belong—develop greater adhesion than round bars, but many reinforced concrete experts think the claim fallacious.

The larger steel bars are arranged longitudinally, generally in way of the deck line and the bottom of the ship, while there are also rods of nearly the same size arranged transversely, the whole being connected by small bars from 3/16 in. to ¼ in., forming, say, a 6-in. mesh over the whole surface, making as far as possible a monolithic structure, a reduction in the number or total sectional area of the rods, both longitudinally and transversely, being arranged towards the ends of the vessel. In order to resist the diagonal tensile stresses induced in a beam by the action of the shearing force, stirrups are frequently introduced extending between the tension and compression members. They may be considered as the web members of a truss system, the triangulation of which will vary as they are placed vertically or diagonally.

The resistance of concrete to tension is generally neglected and it seems desirable to neglect it in ship design, but attention should be given to the fact that concrete is comparatively weak in tension, and therefore may be rather unsound for some part of the full thickness of the surfacing, and, consequently, the watertightness depends on a section of less thickness. It seems advisable at the present time to employ a factor of safety of six as regards the crushing strength derived from experiments on concrete blocks made in the ordinary way, and allowed to dry out in the air, such crushing strength being that obtainable at three months.

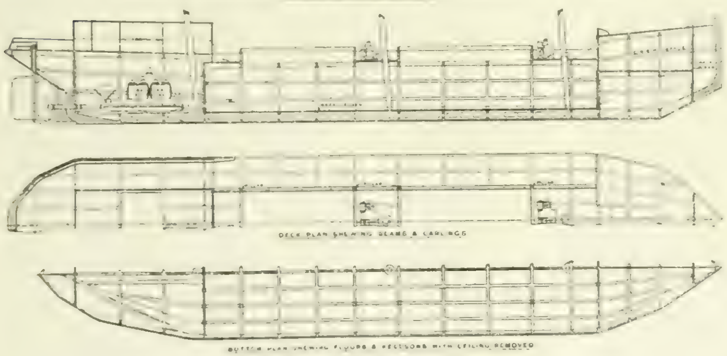
In ordinary building work, considerable dependence is placed upon "adhesion" of concrete to steel, as it is called, but perhaps it would be better to speak rather of the "grip" as indicating that the bond between the steel and the concrete is derived chiefly from the contraction of the concrete in hardening in air. Therefore precaution is taken to give a mechanical bond by hooking or bending the ends of all reinforcement. It will be found advantageous to employ concrete richer in cement than that ordinarily used for buildings, and made with ballast or other coarse material—sometimes called aggregate—restricted in size. There is also another element in question, as to what reduction in stress, if any, should be allowed in concrete which is always kept in water, and that which is alternately wet and dry, while it is necessary in addition to ascertain what effect salt water has on the strength of concrete as used in a vessel, although data go to show that salt water has no effect on a dense concrete; this is a subject that can well be experimented with in regard to concrete shipbuilding. In a steel ship, say, up to 1,000 tons, it is usual to allow a stress of 8 tons per sq. in. of the steel, but in view of the uncertainty of the behavior of the concrete work at sea, it will no doubt be found advisable to allow only 1/5 of the ultimate tensile resistance for the reinforcement.

**Weight of Hull.**—The weight of reinforced concrete hulls is the most serious problem in the adoption of this type of vessel, the concrete being 143 lb. per cu. ft. plus the reinforcement. The bare hull with fittings of a coasting vessel of, say, 300 tons deadweight will weight 130 per cent more than that of a steel vessel, while the increase in total displacement is about 40 per cent—see Table I. But in another way, if a concrete coaster was built of the dimensions and coefficience of fineness of a 420-ton deadweight steel vessel, it would only carry 300 tons deadweight on the same draft. The linear increase—length, breadth, and depth—would be 12 per cent to 14 per cent greater for a concrete vessel than for a steel vessel.

FIG. 8

GENERAL ARRANGEMENT PLANS OF 500 TON REINFORCED CONCRETE COASTER

155 0 B P 29 6 x 13 3 MLD


DECK PLAN SHEWING BEAMS & CARLINGS
BOTTOM PLAN SHEWING FLOORS & KEELSONS WITH CEILING REMOVED

"The Engineer"

FIG. 9

MIDSHIP SECTION OF 500 TON COASTER

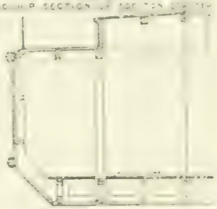


FIG. 10

MIDSHIP SECTION REINFORCED CONCRETE BARGE

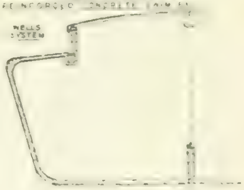


Table I shows a comparison of a 300-ton deadweight auxiliary coaster in concrete, wood and steel. The figures in the table of the 300-ton concrete vessels are based on the ordinary method of construction, as shown in Figs. 1 to 3, and not in the author's improved method of construction shown in Fig. 8. The practice of stating that a concrete hull is from 50 to 70 per cent heavier than a steel vessel of the same dimensions does not give a fair comparison, because the concrete hull would carry much less cargo. The method of comparing the weights to vessels of similar deadweight has therefore been adopted. It will be seen that the total steel is only 27 per cent, the reinforcement alone accounting for 25 per cent of that of a steel vessel of the same deadweight capacity. The weight of the bare hull of the 500-ton vessel, illustrated by Figs. 8 and 9, is only 400-tons, which shows a reduction of 15 per cent, as compared with the figures of the 300-ton concrete vessel. A 1,000-ton deadweight towing lighter would weigh about 90 per cent to 100 per cent more, the displacement being about 25 per cent more, and the linear increase 7 per cent more than that of a steel lighter of the same deadweight. The percentage difference in weight gradually [illegible] up to, say, 25 tons deadweight.

TABLE I—COMPARISON OF 300-TON D. W. VESSELS IN CONCRETE, WOOD AND STEEL.

| | Reinforced concrete. | Wood. | Steel. |
|---|---|---|---|
| Length | [illegible] | [illegible] | [illegible] |
| Breadth | [illegible] | [illegible] | [illegible] |
| Depth | [illegible] | [illegible] | [illegible] |
| Draught from bottom of keel | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| Time to construct | [illegible] | [illegible] | [illegible] |
| Weight of steel, tons | [illegible] | [illegible] | [illegible] |
| Weight of [illegible], tons | [illegible] | [illegible] | [illegible] |

**Disadvantages.**—The principal disadvantages are: (a) Greater weight and, consequently, greater displacement for the same deadweight. (b) Increase of net tonnage and consequent increase in port and harbor dues. (c) Increased cost of building and launching ways. (d) Longer time to repair if bottom repairs are necessary.

**Advantages:** (1) Much less steel than is necessary for a steel vessel, and no waste due to scrap. (2) No loss of strength due to rivet-holes and jointing as in a steel vessel. (3) Cheaper and quicker construction. (4) Very little skilled labor, no platers, anglesmiths, or riveters required. (5) Longer life and reduced depreciation. (6) Reduced upkeep and repair bill. (7) Freedom from dry rot as in wooden vessels, and freedom from corrosion as in steel vessels. (8) Smoother surface and less skin friction.

With regard to depreciation, so far as can be at present ascertained, the concrete should last for several hundred years. Depreciation, however, may take place in the steel bars due to corrosion and fatigue of the metal. The former will only occur if the concrete is permeable to water and air; this can be avoided by a careful selection of materials used and by strict overseeing of the mixing and casting operations. The question of fatigue of the metal would depend upon the stresses set up on the steel due to the "working" of the ship, but this is not likely to affect the vessel up to, say, the first 50 years of its life.

**Local Strength.**—Damage as a result of a collision should not be so serious as some critics appear to imagine. As an instance of the strain reinforced concrete is capable of withstanding, there is in Flanders today a tank of a water tower that was brought to the ground with a crash by the legs having been shot away, and yet the tank is still capable of holding water. It is 66 ft. by 33 ft. by 8 ft. 6 in. deep. The forces set up by collision are practically incalculable, and depend upon the speed of collision, the angle of the impact, the point at which the impact occurs, and other factors. However, the local strength of the structure can be arranged to withstand a momentum or blow which compares quite well with ordinary steel construction. The repairs can be made quickly, but bottom repairs may require three weeks to harden before the vessel can be loaded and put to sea.

**Classification Rules.**—At present there are no recognized rules for the construction, although all of the Classification Societies are studying the subject. The Norwegian Veritas have formulated some rules which include the following: The stress on the steel is not to exceed 6.35 tons per sq. in. when in compression and 5.8 tons per sq. in. when in tension. The modulus of elasticity in the concrete is to be taken as 1/15 of steel. The stress when in compression not to exceed 570 lbs. per sq. in. or 1/6 the strength of the concrete. The stress when in tension not to exceed 57 lbs. per sq in. The outer bottom, between the floors, is to resist a water pressure equal to 50 per cent more than the maximum draught, and in foreign-going vessels for 20 per cent amidships—25 per cent of motors fitted aft—to resist a pressure of twice the vessel's maximum draught. The inner bottom, where fitted, to resist a pressure equal to 25 per cent more than the maximum draught. The sides of the vessel between the frames to resist a pressure of 75 per cent of the maximum draught, the forecastle 60 per cent, and the bridge or deck-house 50 per cent. The deck between the beams to resist a pressure equal to 35 per cent of the maximum draught. Stanchions to beams and hatch ends are supposed to bear a weight of water 4.35 ft. on the main deck, and 2.85 ft. on the upper deck. A water-tight bulkhead to resist a head of water equal to its height, plus 3.35 ft. The deck and bulkhead steel rods to be covered with at least ⅜ in. of concrete, and those in the bilges with at least ¾ in. of concrete. Where rods have to resist pressure, they are to be spaced not more than 15 diameters apart. The overlap of rods to be 60 times the diameter. Welding is only allowed by special permission. A solid fender of wood to be fitted for the whole length of the vessel above the load-line. Ceilings and cargo battens must be fitted in all cases. When the hatch coamings are made of concrete, they must be boarded with wood, or protected in some other way against knocks. The stern frame is to be the size required for a steel vessel of similar size.

Lloyd's Register of Shipping are prepared to give an "A" Experimental Class to vessels approved by them, and will, no doubt, in due time, prepare rules, as also the British Corporation Registry Bureau Veritas, etc.

**Concrete Material.**—The best concrete is the concrete that is the densest—the principal consideration is its permeability. To obtain the necessary density the cement must be finely ground, the aggregate carefully graded and not too coarse, and the mixing thorough. If the concrete is too rich it is subject to greater contraction and cracks. It is made of cement, sand, and aggregate, and for ship work the proportions are usually of 1 to 1½ to 1½ by weight, although the author prefers to specify a mixture of 1 to 3 graded ¼ in. downwards. The cement usually obtainable is to the British Standard Specification, which provides for a residue on a sieve 180 by 180 = 32,400 meshes per sq. in., not exceeding 14 per cent. The finer the grinding the better, and as manufacturers now often produce cement with up-to-date machinery, a residue of 68 per cent might be insisted upon with advantage. The great point is to get a concrete that is not only strong but impervious to water, for otherwise the reinforcement may rust and throw off the concrete. The sand should be clean and sharp, and pass through a sieve having square meshes 3/16 in. in the clear; the grains should vary regularly between coarse and fine without a large proportion of either extreme. The aggregate must be clean and sharp and able to pass through a ¼-in. mesh, and be retained on a 3/16 in. mesh. If the aggregate is large, the homogeneity, even when tamped, would not be as perfect as it should be. The best concrete will be obtained from crushed granite chippings from ¼ in. dust washed. If crushed granite is not available, and it is proposed to use gravel, preliminary dry experiments can be made by filling a measure with the gravel and then finding the greatest amount of sand which can be mixed with the gravel and shaken into the same measure. This will be in the neighborhood of 35 per cent. 10 per cent more than this ascertained quantity should give the correct ratio. Smooth gravel should not be used, but crushed flint and crushed gravel would do very well.

**Reinforcing Material.**—The steel for the rods is usually shipyard quality of mild steel 28 to 32 tons per sq. in. tensile, although some reinforced concrete experts prefer medium carbon steel—to which category shell discard steel belongs—with 35 to 45 tons per sq. in. tensile, a contraction of area at fracture not less than 45 per cent to withstand bending cold to 180° around a diameter equal to twice that of the bar without fracturing the skin of the bent portion. All bars used to be bent cold, and any showing signs of brittleness in the process of bending to be rejected.

**Structural Details of Concrete Work.**—A minimum covering of the reinforced steel work with concrete is desirable so as to reduce the weight of the structure, while, at the same time, it must be sufficiently strong to prevent the concrete from breaking away under the torsional and other stresses that a vessel is subject to. For the slab work it will be found necessary to have at least a covering of 1½ in. of concrete over all the bars, floors, frames, and keelsons, and where heavy bars are used it is advisable to have a covering of not less than 1 in. of concrete, and even 1¼ in. may be necessary. The deck may have a granite finish composed of ¼ in. washed granite and cement gauged 2½ to 1. laid at the same time as the under concrete, and sprinkled with fine carborundum before the casting is finished. The latest vessels being constructed by the author are having a chequer pattern cast in the finishing coat. For a 300-ton vessel a 3-in. shell or slab work will be found sufficient, for a 500-tonner 3½ in., and for a 1,000-tonner 4 in.

**Structural Details of Hull, Steel Work and Fittings.**—The stern frame requires special consideration and is designed to ensure proper attachment to the reinforced concrete work, especially where a stern tube is fitted. Fig. 2 illustrates the author's patent stern frame, the construction in several pieces being really a war measure and designed to reduce the amount of forged work to a minimum. It will be noticed that the reinforced rods are well connected to the plates and angles. At present it is hardly worth while to make the rudders of concrete, although this is quite possible for large ships; the same remarks apply to masts.

**Cost of Construction.**—The prime cost of the finished reinforced concrete work for an ordinary vessel with ship-shaped lines at the present time should average £8 15s ($43.60) per ton, made up with the double forming at 18s. per sq. yd. for timber and 6s. 6d. for labor—the concrete at 1s. 8d. per cu. ft., and the round steel bars from £16 10s. per ton for the large diameter to £22 10s per ton for the small diameters. Vessels with straight lines will cost less. and probably a saving of £1 to £1 5s per ton will be made. the usual establishment charges and profit being added. These figures are based on a 300-ton deadweight coaster. for the first vessel only. Larger vessels would, of course, show a reduction. Assuming that the shuttering will last for five vessels of the same design, the cost of the wood could be divided over that number, but would require an addition of 10 per cent of wood in each case to cover depreciation and damage. If the wood were coated, as mentioned on page 13, the straight shuttering might last for eight vessels and the curved for six vessels. The cost of removal and re-erection for the second and subsequent vessels might be taken at, say, 9s. per sq. yd. for double shuttering on each occasion. The cost of fenders, wood work generally, fittings and equipment will be the same as for a steel or wooden vessel of the same size, but owing to the larger dimensions will be about 8 per cent greater for a vessel of the same deadweight. A considerable reduction is obtainable in the labor, because anglesmiths, platers and riveters are practically dispensed with. Taking the hull complete and comparing with steel and wood construction, even if the steel is obtainable at £11 15s. per ton, concrete vessels of the same deadweight should, if standardized, be constructed at 20 per cent less cost than a steel vessel, and 10 per cent less cost than a wooden vessel. The machinery for propulsion will, of course, cost more because of the extra displacement. With regard to the time for construction after, say, three building berths had been prepared, with ample labor available, and after the first vessel has been cast, the one set of shuttering, so long as it lasts, should enable a barge of 130 tons deadweight to be completed and launched every ten weeks, a 300-ton deadweight coaster every 16 weeks, and a 1,000-ton deadweight coaster every 20 weeks.

## The Croydon and Wolverhampton Sewage Disposal Experiments

[illegible]

**Croydon Experiments.**—In connection with the question of utilization of sewage to the best advantage, some interesting work has been done at Croydon sewage farm during the last two years by Mr. J. E. Farmer, F.C.S. The policy adopted there is based on the principle that the solid matter in sewage deposits more nitrogen than mineral fertilizers. This being so, the soil new to sewage treatment would have a balance of mineral salts, and with the help of nitrogenous manure would produce heavy crops at first. If, however, owing to the long continued application of sewage, the nitrogen is added at a greater rate than its depletion by cropping, and without a corresponding increase of the mineral matters, which are also depleted by cropping, the soil eventually becomes out of balance for heavy crop production. The operations at Croydon which consisted of the application of artificial fertilizers, lime, basic slag, etc., in order to restore this balance, resulted in doubling the yield, and have been financially successful. I believe this is the first sewage farm where a systematic and scientific use of artificial fertilizers has been tried to restore the balance of mineral and nitrogenous matters in the soil.

**Experiments at Wolverhampton.**—Experiments have been carried out recently by Mr. Wm. Clifford, M. Inst. C. E. of Wolverhampton, in order to determine the type of tank best adapted for sedimentation of sewage, and to prevent the short circulating and eddies which all who have tried by means of a color test to time the passing of a liquid through a tank have no doubt observed. The underlying principle of Mr. Clifford's experiment is to dissipate the energy of the incoming sewage, and bring it to rest in the shortest possible time, to prevent eddies, and to ensure that all the sewage received into it should remain for an equal period of time in the tank. The large number of exhaustive experiments carried out were of remarkable interest, and resulted in the design and construction of the sedimentation tank used in connection with the activated sludge system at Withington, Manchester, which so admirably fulfills these functions, notwithstanding the fact that activated sludge contains much flocculent matter, and is particularly sensitive to any variation of rate of flow, or increased velocity due thereto. Briefly described, this tank is of the Dortmund type, its essential feature being in the method of feeding adopted. The sewage passing down a central pipe is discharged into a circular vessel of somewhat larger diameter. Outside this a guard chamber is constructed, the dimensions of the tank, the vessel and the guard chamber are so proportioned that eddies are prevented, and the energy of the incoming sewage is effectually dissipated.

**Cost Plus Profit and Bonus Contracts for British Ship Building.**—According to the Report of the Committee of Public Accounts of Great Britain, issued last August, the Admiralty, in the absence of competition, adopted a new form of contract for ship building based on net cost plus establishment charges, with a profit of 10 per cent on the estimated cost and a bonus of 10 to 20 per cent on the amount by which the actual cost proved less than the agreed estimated cost. The establishment charges are taken on one of two bases: either a percentage or as ascertained by the Admiralty. This system has been modified further by transferring to establishment charges certain fixed amounts not bearing any relation to actual or estimated cost.

## Construction Features of the Trans-Australian Railway

[illegible]

The formal opening of this 1,052-mile railway took place on Nov. 12, 1917. The first sod was turned at Port Augusta on Sept. 14, 1912. In mere length the line far exceeds anything of the kind previously undertaken in Australia. It is practically twice as long as all the railways in the state of Tasmania, and nearly half as long as all the railways of South Australia. Between Kolgoorlie and Port Augusta, the gage is 4 ft. 8½ in. The rails used weigh 80 lb. to yard. The ruling gradient is 1 in 80 and though there were long stretches in which the earthwork was very light, the construction nevertheless involved the removal of about 5,000,000 cu. yd. earth and rock. In one 25-mile section through sandhill country some 1,000,000 cu. yd. of excavation was required. Some of the cuts through the sandhills had to be faced with stone to prevent the sand from sifting. In crossing the Nullarbor Plain the line runs for 350 miles without a curve.

**Difficulties of Construction.**—In all its length of 1,052 miles there are no permanent streams, and such supplies of water as were available were wholly inadequate in quantity and mainly unsuitable. On a stretch of 840 miles there was only one known source of supply. For nearly 800 miles, also the country was without a trace of settlement. For the wants of the 3,000 men or so employed on the construction and the hundreds of animals needed for the undertaking, the country yielded nothing for three-quarters of the way but a certain amount of feed for the animals and firewood. Even the latter failed on the great plains through which the line runs for 450 miles.

**Progress of Construction.**—Operations were begun at both ends, and the whole work from start to finish controlled by the chief engineer, Mr. Norris G. Bell. While there were no mountains to cross nor fast flowing rivers to bridge, difficulties were encountered of a type up till then unknown in Australia.

Steam shovels were extensively used in the cuts and sand pits. Scoops and side-tip cars with light lines of railway leading from the cuts were also employed. Motor tractors also were used for plowing up the surface of the ground, and were found to be most useful. Motor cars were found most handy for facilitating the movements of the supervisors. Large numbers of camels were employed. The advance engineering staff was accommodated in a camp train, which consisted of an office car, a store car, a hospital car, etc. As the rails were extended the train advanced so that the supervisors were always on the scene of operations. Owing to shortage of water and the consequent difficulties in transport, the earthwork, etc., could only be carried on immediately in advance of the railhead.

A Roberts tracklayer was employed for laying the rails At one end alone 1 mile of track per day was laid day after day. At times as much as 1½ miles per day were laid. At the western end in one period of 48 weeks the tracklayer covered 249 miles—an average of very nearly 1 mile per working day. In another period of 22 weeks 115 miles were laid.

The bases of operation were Kalgoorlie at the western end and Port Augusta at the eastern. Kalgoorlie had a population of 30,000 to draw upon for labor, and a water supply available. It lies 387 miles inland from Fremantle, with which it is connected by a 3½-ft. gage line. All material and supplies had to be transported over that narrow gage line from the seaboard or other parts of the state. Port Augusta is one of the best ports in South Australia, so that supplies and materials could be landed right at the rail head.

**Special Problems Encountered**—The building of the line necessitated the solution of numerous problems of a most unusual character. The organization of transport and supplies for the thousands of men in the wilderness traversed, the water supply question, and the necessity of undertaking all sorts of subsidiary enterprises which normally form no part of railway construction, all added to the task. To meet these special conditions the Commonwealth Railway Department had to become a wholesale and retail storekeeper, a boarding house keeper, an owner and breeder of camels, a dealer in horses, a hospital board, a branch of the post office and savings bank, and many other things.

The stores, fixed on wheels, on the eastern section, catered for about 2,000 people scattered along 400 miles of line. They carried a stock worth nearly $100,000, and supplied anything and everything—groceries, draperies, boots, medicine, hardware, silk shirts, and even brilliantine for the hair. The store on wheels carried not only a traveling pay office and a general store, but baker's, butcher's and green grocer's shops.

The men could buy food at reasonable prices, and cook it themselves, or they could get board at a ranch run by the Commonwealth. Every provision was made for accidents or sickness among the workers. On each end of the line was a well equipped hospital car with a qualified chemist and dispenser. Medical attendance was also available. For these specal services the workers on the line paid 12 ct. each per week.

At the bigger and more permanent depots and quarries, where large numbers of men with families were working, schools were established for the children, the State supplying teachers. There were several hundred children along the line. The main camps were at the head of the road in each section. From these camps the rails were pushed forward from day to day, and at frequent intervals the camp itself was moved forward so as to keep the gangs as near as possible to their work.

## Training of Engineers for Specialization in Waterworks Practice

At a general meeting of the Institution of Water Engineers at London last June an interesting discussion on the training of water engineers was submitted by Mr. E. J. Silcock, representative of the Institution on the British Engineering Training Organization. Mr. Silcock considered the subject under two heads: first, the broader question of the training of civil engineers, and, secondly, the amount of specialization necessary for those who intend to practice as water works engineers. His outline of the scheme of study for a youth intended to follow the profession of civil engineering was as follows: (1) A good general education at a public school; (2) education at a university on the theoretical side of the profession for a period of two years; (3) an apprenticeship for a period of three years, with a civil engineer in active practice. He suggested that the training at the university should commence at the age of 17. He also suggested a radical alteration in present methods to adapt the university course more or less to the conditions appertaining in business life; i. e., office hours should be maintained, and holiday periods should be much curtailed, According to his views no attempt should be made to teach drawing, which could be better done in the office when period of apprenticeship arrived: nor should it be necessary to teach the pupil mere manual dexterity with machine tools.

As to the specialized training of water engineers, Mr. Silcock suggested that the students should specialize immediately after leaving the university by entering the office as a pupil of a member of the Institution of Civil Engineers, who either holds a public appointment as engineer to a water works undertaking, or one who, if in consulting practice, is mainly engaged in the design and construction of water works. It was thought desirable that there should be established a diploma in water works engineering, which should be regarded as supplementary to, and not a substitute for the associate membership of the Institution of Civil Engineers. One point in connection with the pupilage in the office of a consulting engineer which received attention was the suggestion that the pupil should study all the reports, specifications, tenders and bills of quantities. It was remarked that many consulting engineers refused to allow their pupils to have access to these documents.

## Algal Growths and Chlorine Treatment of London Waters

From the report of Dr. A. C. Houston, Director of Water Examination, Metropolitan Water Board, London, for the year ended March 31, 1918.

**Treatment of Algal Growths.**—It has frequently been pointed out that in algal treatment the offending growths can be destroyed, yet the risk may remain of other and more resistant growths taking their place. A notable instance occurred in 1917 during the continuous treatment of No. 1 reservoir at the West Middlesex Works with copper sulphate (1 in 4 millions). The growths (Fragillaria, Asterionella, Stephanodiscus, filamentous confervoid growths, etc.) affecting the neighboring reservoirs were almost completely held in check, but a fresh growth, composed of such excessively minute cells that they pass readily through four folds of fine linen, developed abundantly and caused serious blocking of the filters. Incidentally, this result shows that linen filtration results cannot always safely be compared with slow sand filtration.

In August, 1915, a very decided growth of Stephanodiscus occurred in the Stoke Newington reservoirs, causing rapid choking of the filter beds. At the beginning of July, 1917, a very similar growth (Cyclotella) began to develop, but the part played was no longer a passive one. By a judicious combination of chlorine and copper sulphate treatment the filtration difficulties were entirely overcome, no water was wasted, and the use of the reservoirs as settling and purifying agents was practically continuous. The procedure was to shut off the west reservoir for a few days, whilst it was being treated with copper sulphate (1 in 2 millions), and to short-circuit chlorinated water through the east reservoir on to the filter beds. A recrudescence of the growth occurred later on more than one occasion, but it was each time dealt with in a similarly successful manner.

**Effect of Algal and Other Growths in Water Purification.**—The role played by these organisms in connection with water purification is not fully understood. Some of them exercise a useful function in reducing the hardness of water and, within certain limits, in increasing the effectiveness of the protective film formed on the surface of the sand filters. On the other hand, they may sometimes give rise to taste troubles, and when superabundant "seal up" the filter beds so rapidly as to disorganize the whole machinery of sand filtration. In the latter event, although in themselves quite harmless, they may lead to imperfectly purified water being sent into supply. Those who have studied these matters know that the simultaneous occurrence of heavy floods, abundant growths (especially those kinds which readily block filters and give rise to taste troubles) in the reservoirs and increased consumption of water might create embarrassing, if not serious, condition of affairs. How far algicidal treatment, chlorination of river water, and the use of filters, which can be cleaned as rapidly and as often as the necessities of the case demand, are destined to enter into the problem, must be left for the future to decide.

**Chlorination of Raw Water.**—This year a cautious opinion must be expressed, not of the efficacy of chlorine as a germicidal agent, but of the difficulties still to be overcome of adding this reagent to water in the proper dose. With the particular apparatus used, quite successful results were obtained during the warm weather, but when the air and water temperatures fell below a certain point, troubles were not far to seek. So far as the instrument was concerned, these difficulties were largely overcome by artificially heating the temporary building in which the apparatus was "housed." Yet this procedure availed nothing as regards that part of the instrument which lay outside the building and was indeed immersed in the water. It is now evident, as the result of practical experience during cold weather, that either the gas must be added as a solution to the water to be sterilized, or else some improved form of porous diffuser must be discovered. The matter is still under active investigation.

For the period April 1, 1917, to March 31, 1918, 23,426 million gallons of raw Thames water have been treated during

315 days (West Middlesex supply) and 313 days (rest of Staines supply) out of a total of 365 days. The intermissions, of course, were caused by floods, when the water was too turbid for filtration purposes and stored water had to be used instead. The proportions were 84.3 per cent raw water and 15.7 per cent. stored water during the year. The estimated saving of coal amounts to about £15,227. The cost of the chloride of lime was about £3,485. The net saving by reduced pumping thus amounts approximately to £11,742.

The dose has varied according to circumstances, but was usually 0.5 in 1 million (1 in 2 millions), in terms of available chlorine. With bleaching powder (chloride of lime) of 33 per cent. strength this equals 15 lb. per 1 million gallons. Considerable success, however, has also been obtained with smaller doses, 0.33 in 1 million (1 in 3 millions), or 10 lbs of material per million gallons. On the whole, the latest results point to a probable reduction rather than an increase in the average dose. As regards bacteriological results, all that is now aimed at is to produce at least as good a result by chlorination of raw river water, as if the river water had been stored in the Staines reservoirs instead of being chlorinated. The Staines stored water 10 cc. B. coli standard is 60 per cent. "negatives" (40 per cent. "positives"). That is, if 100 10 cc. cultures are made of Staines stored water, 60 of them, on the average, contain no B. coli and 40 of them contain this microbe. Taking a period embracing the bad winter months, namely, from October, 1917, to the end of March, 1918, the average chlorinated raw river water result works out at 83 per cent. "negatives" and 17 per cent. "positives," figures which show that better results, as judged by the B. coli test, can be obtained by chlorination than by storage. Despite the magnitude of the treatment (70 to 80 million gallons treated daily), no complaints have been received as regards taste.

**Super-Chlorination and De-Chlorination.**—The two great factors which militate against successful chlorination are extreme cold and short contact. Separately, and still more in conjunction, they tend to prevent sterilization, or if sterilization takes place owing to a super-dose, the water is apt to have a chlorinous taste and to contain active chlorine. By a super-dose is meant a dose in excess of what is actually required under more favorable working conditions. It is always best to provide for so prolonged a contact that however cold the water may be, the active chlorine will have disappeared and the water at the same time have been sterilized. In practice, however, for one reason or another, this may be impossible, and in these cases, especially during very cold weather, super-chlorination and de-chlorination may be of advantage. There is another curious circumstance bearing on the question. It has sometimes been observed in the laboratory that when working with minute doses of chlorine, too slight to produce the familiar chlorinous taste, a slight "iodoform-like" taste develops. This occurs sometimes after a water has been de-chlorinated, at other times it is noticeable only before de-chlorination, yet again it may occur both before and after de-chlorination. On the other hand, no taste, unless perhaps the original taste, has ever been observed after gross chlorination and de-chlorination. Hence in certain cases there may, so far as taste is concerned, be an advantage in heavily chlorinating a water and then de-chlorinating it.

On the whole, speaking of the samples neutralized with $SO_2$, neither temperature nor time appeared to be dominating factors as regards questions of taste.

Next in respect of dose, the amounts (in terms of available chlorine) were as follows: 1 in 15,625, 31,250, 62,500, 125,000, 250,000, 500,000 and 1,000,000, respectively.

The outstanding feature was that with the stronger doses (far greater than would ever be required in practice), despite the extremely noticeable and practically unbearable chlorinous taste of the non-neutralized samples, the ones neutralized with $SO_2$ were completely free from any taste. Indeed, the slight earthy flat taste of the river water often noticed appeared to be removed or disguised, not infrequently, by super-chlorination and SO treatment. Apart from cost of materials and the circumstance that the substances (Cl and $SO_2$) are not separately innocuous in other than minute doses the indication is that a combined (in sequence) super-chlorination and $SO_2$ treatment may be actually advantageous from the point of view both of taste and of sterilization. When, however, the case is regarded from the economic aspect and in relation to the undesirability of using in other than infinitesimal doses substances which apart are not, in the uncombined form, natural ingredients of water, the matter assumes a different complexion. Unfortunately, it is just when the minor doses come to be considered that many of the difficulties arise. Sometimes with, sometimes without $SO_2$ de-chlorination, but quite as often with as without, taste results are obtained, which lead to nebulous conclusions.

# Fertilizing Values of Water Hyacinth

From Indian Engineering

The Agricultural Research Institute, Pusa, has issued a most interesting bulletin on the water hyacinth, showing definitely that it is a valuable fertilizer and further that its fertilizing properties are receiving commercial recognition. An analysis of the dried plant gave 24.2 per cent of ash and the ash analyzed to

| | Per cent |
|---|---|
| Potash | [illegible] |
| Soda | [illegible] |
| Lime | [illegible] |
| Chlorine | 21 |
| Phosphoric acid | 7 |

Rotted water hyacinth is approximately five times as rich in potash as farmyard manure containing a similar percentage of water, and only a little less rich in the same fertilizer as the best marine sources of kelp; and apart from its high potash content it is at least as rich as farmyard manure of the same water content in both nitrogen and phosphoric acid. The effects of potash on the yield of jute are quite remarkable. The addition of carbonate of potash to an otherwise complete manure of castor cake, phosphates and lime produced a yield of nearly 34 maunds of fibre per acre, while plots which did not receive potash but were otherwise similarly treated produced less than 27 maunds per acre. The value of water hyacinth therefore as a manure for jute growing is apparent, and since jute and the manure grow in the same localities the commercial importance of water hyacinth is strengthened.

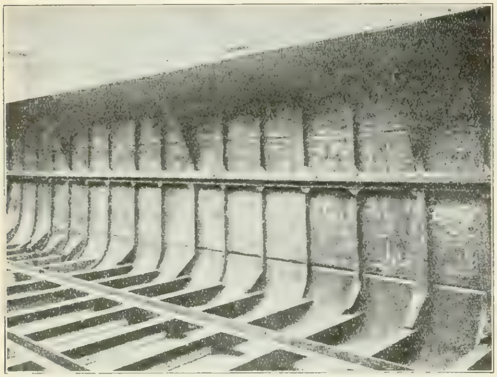
As regards weight, the fresh green plant contains 95 per cent by weight of water which it is obvious it would never pay to lead to any distance; if rotted, the residue contains from 50 to 60 per cent by weight of water. If the green plant be at once stacked for rotting the exuding liquid carries away a considerable part of the valuable manuring elements; therefore the plant should be dried for a few days before stacking to rot. This reduces its weight to one-twentieth the original weight and by so much reduces the cost of carriage. If the dried plant be burnt and the ashes only taken the weight is further reduced to one-fifth, that is to 1 per cent of the green plant, but in the process of burning all the organic matter and from 1.5 to 2 per cent of the nitrogen is lost. However, it is only in the last form that it can conveniently be transported long distances or stored and it is in this form that a favorable market for it is opening out.

The green plant is not likely to be put to any industrial use; the rotted plant, having about the same manurial value as cowdung might be used as manure, just as cowdung is used in the immediate neighborhood where it is collected and rotted. The dried plant, however, will stand some carriage and make a good manure as it contains from 1.5 to 2 per cent of nitrogen and about 8 per cent of potash. The ash will always possess the greatest value as a manure on account of its small bulk and ease of transportation. It has been found to contain as much as 35 per cent of potash, and an average figure for the Dacca district would seem to be over 25 per cent. The ash is therefore several times richer in potash than ordinary wood ashes. It is satisfactory to find that Government officers are taking a keen interest in getting the weed put to use as manure.

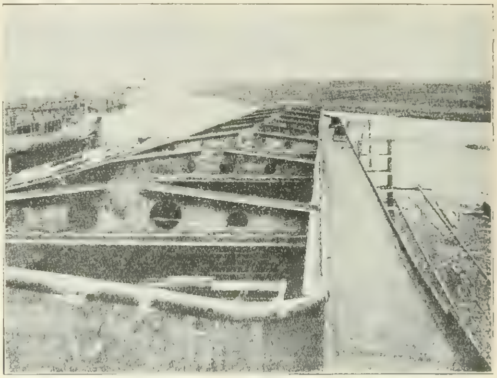
# The First English Electrically-Welded Barge

From The Engineer.

Particulars are now available of the interesting—and completely successful—experiment in rivetless shipbuilding, carried out at a yard on the Southeast Coast. The first steel vessel constructed entirely without rivets was recently launched. She has since been in service with full cargo during exceptionally rough weather, and has, we understand, passed satisfactorily in every way through the severe tests imposed.



Interior View of Electrically Welded Barge.



View Along Deck of Electrically Welded Barge.

The recent progress achieved in electric welding by means of the flux-coated metal electrode process, and its successful use at admiralty dockyards and elsewhere in the construction of the equipment and superstructure of various vessels, led to permission being obtained for the erection of a standard barge, with riveting eliminated and electric welding substituted throughout. Such a craft may be exposed to considerable rough usage in dock, besides being subjected to severe towing stresses. Seeing that material already available on the site where she was built was utilized, the barge differs in no way from the standard riveted type with lapped joints, excepting that the hull plates were arranged for clinker build and the plate edges joggled to permit of horizontal downward welding in order to reduce the amount of overhead work, which is more difficult of execution.

The vessel to be welded was 125 ft. between perpendiculars, and 16-ft. beam, with a displacement of 275 tons. The hull was rectangular in section amidships, with only the bilge plates curved. It was built up of 71 transverse frames, and contains three bulkheads, those fitted fore and aft being watertight, and that amidships being non-watertight. The shell plating was ¼ in. and 5/16 in. All the joints were lapped.

The first day's work was poor, though all the operators were first-rate men, with extensive experience of electric welding in the shop on minor repairs and on structural work at shipyards. The poorness of the work was probably due to the novelty of the undertaking and to the position —lying flat on the keel—which the men had to adopt to get to the joints. In a few days, however, when they became accustomed to the job, the speed and quality of the work improved so as to become equal to that achieved in workshop standard practice. With the more difficult welding, such as that in the vertical butt joints on each shell plating, and overhead work underneath the keel and on bilge plates, it was noted that the quality of welds was excellent. For this overhead work special electrodes were employed, and proved well worth the slightly increased cost. All water-tight joints up to and including the underside of bilge plates were continuously welded both inside and outside, the other water-tight joints being welded continuously on one side and tack welded on the other. On the shell plating the continuous welding was on the outside in all cases. For internal non-water-tight joints and frame construction tack welding was adopted, the length of welding being carefully calculated to give a margin of strength over a similar riveted joint. Taking all positions of work into consideration, the average speed was 4 ft. an hour at the commencement, while towards the end of the work an average of 7 ft. an hour was easily obtained.

Some interesting details have been given to us of the comparative cost of an electric welded and riveted barge. In labor, 245 man hours were saved in construction, which can easily be improved on in future work. More than 1,000 lb. of metal was saved, owing to the absence of rivets, but it is estimated that greater economy will result when the design is modified to suit electric welded ship construction. The total cost of welding was £301 ($1,500), detailed as follows:

| | |
|---|---|
| Electrodes | £178 |
| Electric current | 61 |
| Men's time | 62 |
| | £301 |

It is realized by the Admiralty experts that the proportion of cost for electrodes is high, but this is mainly due to the present limited demand. Demand and competition will have the usual effect, and should reduce the cost of this item by at least 60 per cent. It will then be possible to build a vessel of this size with an estimated saving of from 25 to 40 per cent of time and about 10 per cent of material.

As a result of this demonstration, the yard has prepared a new design of barge, in which it is proposed to incorporate electric welding and riveted construction to the following extent:

TO BE WELDED.
- Coamings.
- Shell seams to frames.
- Deck butts to beams.
- Bulkheads (including boundary bars).
- Keel plate butts to be welded overlaps.
- After shell seams welded.

TO BE RIVETED.
- Floor riveted to frames.
- Beam knees to frames and beams.
- Frames clear of shell seams.

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# 220 Concrete Ships Under Construction in Great Britain

Reinforced concrete vessels representing some 200,000 tons of shipping were under construction in September at yards of the United Kingdom. According to the Engineering Supplement of the London Times, some 220 ships were being built at the 20 yards. The capital outlay for these ships, aside from the cost of land and shipyard plant, was estimated to be nearly $20,000,000. On the designs adopted the saving of steel is stated to be fully 70,000 tons on what would be required for steel ships of the same carrying capacity. The vessels at present under construction comprise 1,000-ton seagoing barges and steam tugs.

# The Life and Work of Institution of Civil Engineers

On Jan. 2, 1918, the Institution of Civil Engineers completed the first century of its existence. At the regular meeting on the following week an interesting account of the life and work of the institution was presented by Dr. Tudsbery. The following abstract of the paper appeared in The Engineer.

In his statement Dr. Tudsbery recalled that the Institution was founded on the 2d of January, 1818, at a meeting held at the Kendal Coffee House in Fleet St., and its establishment marked the transition of engineering in England from the practice of a few craftsmen, whose personal qualifications had led to their adoption of advisory functions, and whose knowledge was largely the result of individual observation and experience, to a profession inspired and regulated by the accumulated knowledge of many observers and practitioners.

The number of the founders has been variously stated, but the original records show that they were eight—a fact corroborated by a statement in the memoir of Palmer contained in the fourth volume of the "Proceedings." Their names were James Ashwell, Charles Collinge, Joshua Field, James Jones, John Thomas Lethbridge, Thomas Maudslay, William Maudslay, Henry Robinson Palmer. Field became president in 1848, and Palmer became vice-president in 1830, but died without attaining to the presidency; a memorial of him exists in the Palmer Scholarship which is in the award of the Council and is tenable at the University of Cambridge. These eight men were for the most part engaged in the construction of machinery and their use of the expression "Civil Engineers" accorded with the distinction drawn then and subsequently between "civilian" and "military" engineering—a distinction that recent experience may tend to modify.

The society thus formed proceeded vigorously to pursue its object of promoting and diffusing the knowledge necessary for the efficient practice of engineering, by means of discussion of theses and questions bearing thereon, and by the consideration of descriptions of structures and works. As an illustration of the early conversations it is recorded that the meetings on the 17th of March and the 24th of March, 1818, were devoted to the discussion of Bolton's (sic) and Watt's "Parallel Motion" and it was resolved that "it is the opinion of this meeting that the parallel motion of Bolton and Watt is mathematically incorrect, arising from the extremities of the two radii passing through unequal arcs in the same space of time; but that, to a certain extent, in practice the deviation is not productive of material inconvenience." The first paper received by The Institution was presented by Joshua Field on the 27th of April, 1819, being one of a small group of papers on canal locks.

The meetings continued to be held at the Kendal Coffee House until April, 1819, from which time until February, 1820, they are recorded as having taken place at Gilham's Coffee House. In March, 1820, accommodation was hired in the house of the Rev. Mr. Harris, in Buckingham St. Adelphi.

On the 21st of March, 1820, Thomas Telford accepted an invitation to become the first president of the institution, and in his address he made the following remarks on the course which should be observed to promote its success:

"In foreign countries similar establishments are instituted by Government, and its members and proceedings are under its control; but here, a different course being adopted, it becomes incumbent on each individual member to feel that the very existence and prosperity of The Institution depend, in no small degree, on his personal conduct and exertion; and the merely mentioning the circumstances will, I am convinced, be sufficient to command the best efforts of the present and future members, always keeping in mind that talents and respectability are preferable to numbers, and that from too easy and promiscuous admission, unavoidable, and not unfrequently incurable inconveniences perplex most societies."

Under Telford's presidency The Institution grew steadily in importance, and on the 3d of June, 1828, received a Royal Charter of Incorporation, for the objects set forth in the well-known words of Tredgold, which expand, though they differ little from the original purpose expressed by the founders.

In 1834 The Institution moved to a small house at No. 1, Cannon-row, Westminster, and at Christmas, 1838, entered upon the occupation of No. 25 Great George St., which, with some alterations and additions made in 1846 and 1868, sufficed for its needs until 1896, when it was rebuilt upon the sites of Nos. 24, 25 and 26, Great George St., to the designs of the late Mr. Charles Barry, F.R.I.B.A. Fifteen years later these premises were required by Government in connection with their scheme of public offices, and the Institution was assisted to obtain its present more extensive site, and to erect this building, designed by Mr. James Miller, A.R.S.A., in 1913.

The conversations and discussions held at the Institution during its early years were not published or circulated by it; but, to a limited extent, abstracts of them appeared in the Athenoeum. A selection of papers and addresses prior to 1842 was published in three volumes of "Transactions" (4to) by Weale in 1836, 1838 and 1842; but the earliest record of discussions is contained in Vol. 1 of the "Proceedings" (8vo) which consists of five annual parts, referring respectively to the years 1837-41. The series of volumes then begun has reached 204 in number. They contain most of the 4,239 papers which have been presented to the Institution, as well as numerous addresses, lectures and reports of researches and inquiries made by committees formed for such purposes. This literature covers the entire field of British engineering practice, and includes in the reports of the debates, the considered opinions of exprienced engineers upon a multitude of problems presented by the new conditions encountered in the undertakings and investigations described. These professional records, contributed voluntarily and freely by many thousands of the members, past and present, form a response to the claims of the Institution not unworthy of the ideals of its founders and of the prestige enjoyed by the body corporate. The publications have kept substantially the style adopted in 1837, having passed through the hands of only three editors —Mr. Charles Manby, who became secretary in 1839, Mr. James Forrest, who succeeded him in 1860 and held the office until 1896, and the present secretary. It is to the credit of those who originated the proceedings that their form has been adopted as a model by almost every engineering society of importance that has come into existence during the period covered by their issue. A later branch of professional inquiry, which although perhaps not foreseen by the founders of the Institution, is closely identified with this part of their project, is experimental research and allied investigation, of engineering problems. During the last 20 years much valuable work has been done in such directions by means of committees; the first inquiry of importance having been "The Thermal Efficiency of Steam Engines," and the last undertaken, and now in progress, "The Deterioration of Structures Exposed to Sea-action." Supplementary to the work of recording, discussing and investigating matters bearing on engineering practice, it has been the care of the Institution to form a reference library containing all literature relating to the profession, and deemed to be worthy of permanent retention. This library, which has developed from a bequest of Telford's private library, is in its particular character unrivaled in completeness, and is unique in its possession of original reports and other documents relating to the work of the early masters of the engineering profession.

Turning to the second phase of the Institution's activities —namely, its concern with the education and training of those who sought recognition by it—the first trace of action in that direction is found in the establishment in 1838 of a class of graduates, but it was not until 25 years later that the Institution's interest in the training of engineers took a very practical shape. A large part of the presidential address of Sir John Fowler in 1866 was devoted to the question of the best preparation for engineering pupils.

His views coincided remarkably with the tenets and practice of the Institution at the present day. He said: "The preparation and training for the Civil Engineer may be shortly described as follows: 1. General instruction. or a liberal education. 2. Special education as a preparation for technical knowledge. 3. Technical knowledge. 4. Preparation for conducting practical works."

This deliverance of Sir John Fowler foreshadowed the policy of the Council, to which effect was given in the following year by the organization of the "Students," when the foundations were laid of that plan of preparation and training for the engineering profession which it has been the privilege of this Institution to originate and encourage. The creation of the student class on the 26th of June, 1867, was contemporaneous with the extinction of the class of graduates, which had possessed the privilege of corporate membership.

In 1870 the Council compiled and issued a statement on the education and status of civil engineers in the United Kingdom and in foreign countries, and in 1897 the Institution found it desirable to establish its own examinations, both in general and scientific education. This step was taken, after conference with persons experienced in educational matters, under the presidency of Sir John Wolfe Barry, who has remained chairman of the Examination Committee for 20 years, and to whose unremitting care and wise counsel the success of the Institution's action in this matter is largely due. The scheme of examination was designed to test suitable preliminary education, and, based on that, competent knowledge of those branches of science which are applied to engineering practice. Consequently, it has been possible to accept many degrees and diplomas of universities and schools of university rank as exempting the holders from the Institution's preliminary and scientific examinations. This, however, concerns only part of the equipment of a young engineer, and the question of his practical training, which has always been required by the by-laws, was systematized somewhat precisely in 1910, and still remains a matter of judgment on the information furnished to the Council.

The position thus reached has been influenced largely by the results of an exhaustive inquiry into the education and training of all classes of engineers, undertaken in 1903 by a committee which included representatives of the leading professional institutions and some important universities, under the chairmanship of the late Sir William White; by a conference of engineers on that subject held at the Institution in 1911; and by a report of a committee on the practical training of engineers, presided over by Dr. W. C. Unwin, which presented its report to the Council in 1914. It is proposed shortly to amplify the tests for associate membership by an examination in some particulars of practical knowledge which are thought to be inadequately proved by the present method of certificates.

The last important stage of the Institution's development concerns the mutual relations of the members as professional men, and their relations with the public who employ them. Even in the original rules of 100 years ago provision was made to remove any person whose action might be regarded as inimical to the interests of the general body; and, whilst those provisions were amplified from time to time, it was not until 1910 that rules were formulated to govern the professional conduct of the members. The general purport of these rules is to ensure that the engineer's utmost skill shall be placed at the disposal of those who employ him, and that the method of his remuneration shall not involve any conflict between his personal interests and those of the clients whom he advises. These simple ethics are still not free from difficulty, so complex are the conditions under which engineering is now practiced, and questions of conduct and etiquette arise occasionally which call for the greatest care and judgment to determine them properly and fairly.

This brief account of the Institution's endeavors to create a literature of engineering, to promote education, and to estabish professional ethics, would be incomplete without reference to its growth and constitution.

As regards numbers, the early records are incomplete, but in 1828, when its charter was granted, there were 156 members; in 1836, when its "Transactions" were first published, the number was 238. Fifty years later the number had increased to 5,100, and by 1914 had become 9,266. At this point, the outbreak of the great war—in which more than 2,700 of the members and students have already engaged in naval or military service, and 246 have given their lives—checked the increase of the roll, though it has not arrested the activities, or, it is believed, diminished the prestige of the Institution.

# Reinforced Concrete Ships

From a paper presented by A. Alban H. Scott, Vice-President, Society of Architects, before the Concrete Institute.

In several references to reinforced concrete ships one notices the phrase that "concrete is poured in." In the opinion of the writer the loose application of this term should be combated. To obtain the best results, concrete should be placed into position as dry possible, and after the concrete has been so placed, and sprinkled with water the result is a material much stronger and much more waterproof than a wet, sloppy mixture, or even a mixture which might be termed plastic; for this reason one would much sooner adopt the method of elevating the practically dry, mixed material in preference to delivery by gravitation.

**Location of Yard for Concrete Ship Construction.**—A good deal of discussion has been taking place as to the suitability of various sites for the construction of reinforced concrete vessels. It is necessary to consider first the materials involved. If we take a boat of, say, 1,000 tons deadweight, we find we shall require approximately 40 tons of clean, fresh water, free from injurious foreign matter, 564 tons of aggregate, 234 tons of sand, 125 tons of cement, 160 tons of steel, and 138 tons of material for equipment in the way of machinery, etc. It is clear, therefore, that the combined weight of the sand and aggregate is 66 per cent of the total required, including equipment. It would consequently appear desirable, so as to save the cost of freightage and the difficulties of transport, that waterways for these shipyards should be looked for in the neighborhood of suitable stone quarries, where crushing plants could be put down and trolley-ways or rope-ways for transporting the material from the quarry to the shipyard could be arranged. It is also possible that cement could be obtained in the immediate district. If concrete in a relatively plastic condition be finally chosen such a method of transport from the quarries to the vessel obviously suggests that the material should be lifted above the ships, and after being mixed at a convenient level the concrete should be transferred by gravity to each particular vessel and part of the vessel requiring concrete at the moment. This method, however, the author suggests, requires too great a percentage of water.

**Design of Concrete Vessel and True Ship Lines.**—With this new form of construction for vessels the temptation to depart from true ship lines must be resisted. For many years investigations have been carried on to ascertain the lines which give the least resistance to a ship passing through water; and because a different material is proposed to be used for certain boats it is submitted a great mistake would be made by departing from proper and regulated lines of the ship in the expectation of securing economies in construction in reinforced concrete. Safety and efficiency in running must be the first considerations. To depart from proper ship lines would involve extra expenditure on the running costs, which would quickly neutralize any saving on the capital outlay of the ship when constructed. No doubt it would be found that if five or six boats were built with the same set of centering there would be no additional cost by having what is known as "circular work." It has been stated that it is more difficult to ge the reinforcement into position by following the true ship lines than if straight lines are adopted. The obvious reply to this is, that it is more difficult to construct upper stories to a building than lower stories, therefore we won't have any upper stories, or if it is more difficult to provide for hatchways, leave them out.

# Resilient Chairs and Reinforced Concrete Ties for Railway Track

From Indian Engineering

The latest type of concrete sleeper brought to notice has the promise of being a success, and deserves to be, considering the careful mathematical investigation made of the various stresses it is subjected to when designing it. Mr. Louis Green of the East Indian Ry. has been working at it in collaboration with Mr. R. St. George Moore of Westminster since 1912, and it has recently been tried out on the East Indian Ry. With a knowledge of the inherent defects found in concrete sleepers previously designed, they set themselves to solve four main difficulties in the problem, viz.: (1) to obtain resilience, if possible, equal to that of the wooden sleeper and cast-iron chair combination; (2) improve the connection between the chair and the ferro-concrete block; (3) scientifically arrange the reinforcement to meet the strains due to variations in the packing of the road; (4) increase facilities for handling. The illustrations, Figs. 1 and 2, show a chair and sleeper in combination with a bull-headed rail. The chair is made of wrought steel plate forming a suspension loop; it is 4 in. wide and ½ in. thick; there is a tendency for the jaw to close slightly when the chair is depressed, but it springs back immediately the pressure is removed. The feet of the chair enter into direct combination with the reinforcement, thus allowing of the resolution of the forces in the chair directly into the lines of reinforcement provided for each specific strain. The distribution of the stresses in the reinforcement is determined largely by the packing of the sleeper, and as consideration has to be given defective packing it results that the total amount of reinforcement is considerably more than would be needed for a perfectly packed sleeper. Obviously, when a sleeper of this kind is uniformly packed under a rail there is very little tensile strain on its top reinforcement, when it is properly packed in its center and loosely packed at its ends there is considerable tensile strain at top, and when it is properly packed at its ends and loosely packed at its center there is a compressive instead of a tensile strain at top, and at bottom a tensile instead of compressive strain. The bending moment therefore is much greater in either of the two latter cases than when the sleeper bears uniformly on the ballast. The reinforcement has for this reason been designed to resist the maximum combined stresses which would be caused by the standard wheel-load when the sleeper is bearing unevenly on the ballast. On Figs. 1 and 2 the lower tension members are marked e, e, e. The upper tension members are marked f, f, f. The direction tensions from the chair are taken by n and g. The tension caused by the transverse bending moments are taken by b, b, b. To these must be added the top and bottom members of the side frames d, d, d. As will be seen from the illustrations the sleepers are in two halves connected by a tie rod which is attached to the chair by ordinary gibs and cotters.

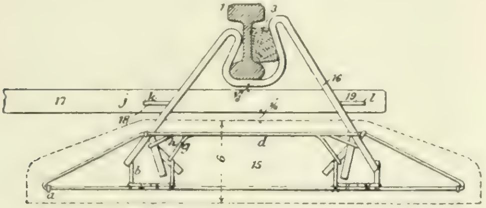


Fig. 1.

In the first designed pattern the chairs were made 6 in. wide of ⅜ in. plate, these were tried on the Shalimar Branch, where 11 sleepers were laid on Jan. 23, 1914. They have stood very well and have even come out of a derailment with only trifling injury when it is believed the D. O. sleepers with which the Shalimar line is laid would have been much more seriously damaged and would have caused obstruction to traffic. Soon after the same type of chairs and sleepers were tried in Howrah freight yard and broke up badly; on examination it was concluded that the wires could not safely take the tensile strains imposed by the bending moments and horizontal components of the load. there were besides bad joints in the reinforcement and bad spacing of upper and lower members. After these failures a further investigation was made of the stresses in the sleepers and the design somewhat modified. On Nov. 24, 1914, and Jan. 20, 1915, 70 of the improved type were laid on the third line between Konnagar and Rishra stations, where the speed limit of passenger trains is 30 miles. They kept well and the road was reported to be easy running and easily maintained. In May, 1915, they were moved into the main line where the speed of trains sometimes reaches 60 miles an hour. The Government Inspector, reporting on them in 1917, said: "The reinforced concrete sleepers referred to in paragraph 5 of last year's report were examined and found to have stood another year's traffic very well. These sleepers were said to cost only Rs. 6-8 for flat-footed rails and Rs. 7-8 for double-headed rails, including fastenings. A vibrating table has been received for making these sleepers. When the first cost and probable life are taken into account it looks as if these sleepers would drive wooden and metal sleepers out of the market." Up to the present, of course, there are no data available for estimating the life of these sleepers, but it is believed they will last from 20 to 30 years. On this basis a comparison is made as follows of the cost per mile per annum of certain kinds of sleepers:

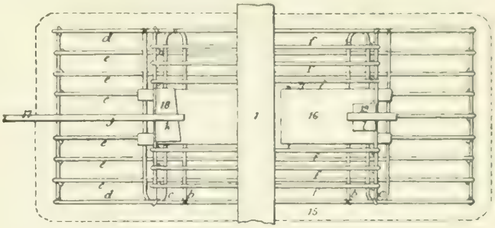


Fig. 2.

(a) Wooden sleepers at 7s each, with cast iron chairs 2.11 square ft. bearing area and 12 years' life, cost per annum ... $127.[illegible]
(b) Wooden sleepers at 5s each, with cast iron chairs 2.11 square ft. bearing area and 12 years' life, cost per annum ... [illegible]
(c) Cast iron pedestal sleepers, with wrought iron tie-bars 2.75 sq. ft. bearing area and 30 years' life, cost per annum ... 109.50
(d) Ferro-concrete sleepers with wrought-iron chairs and tie-bars 3.9 sq. ft. bearing area and 20 years' life, cost per annum ... [illegible]
(e) Ferro-concrete sleepers with wrought-iron chairs and tie-bars, 3.9 sq. ft. bearing area and 30 years' life, cost per annum ... [illegible]

Chairs for flat-footed rails have little resilience by virtue of their shape, but this difficulty has been overcome effectively, as proved by the trials, by making the table of the chair longer than the width of flange of the rail. The attachments consists of a bolt with a square nut and a spring washer, the nut is made to lie close against the tie-rod and therefore cannot turn. The spring washer provides the necessary elasticity in the attachment. Where it is desired to insulate one rail from the other for the purpose of using the rails as conductors for electric currents for signalling purposes, special tie-rods with a central insulating device can easily be substituted in the case of either bull-headed or flat-footed rails. The inventors have patented the sleepers and chairs here described.

# Experiments of Lloyd's Register on Application of Electric Welding to Shipbuilding

From Engineering.

Welding has been applied in countless ways to the manufacture of munitions of war, and the more advanced shipbuilders soon recognized that this method of construction offered almost endless possibilities to ship-building. When the matter was brought under the notice of Lloyd's Register, the committee, with a characteristic desire to afford the shipbuilding community the very latest technical information on the subject, arranged to carry out an exhaustive series of tests, which have extended over a period of six months.

**Nature and Description of Experiments.**—The general scope of the experiments included:

(a) Determination of modulus of elasticity and approximate elastic limit.

(b) Determination of ultimate strength and ultimate elongation.

(c) Application of alternating stresses with—
  (1) rotating specimens,
  (2) stationary test pieces.

(d) Minor tests, such as—
  (1) cold bending of welds,
  (2) impact tests of welded specimens.

(e) Chemical and microscopic analysis.

Tests were carried out on specimens as large as possible, particularly in respect of the static determinations of elasticity, ultimate strength and elongation, some of the test specimens being designed for a total load of just under 300 tons. The advantage of these large specimens was that the effect of workmanship was better averaged and the results were more comparable to the actual work likely to be met with in ship construction.

With alternating stresses the specimens were relatively of small size. For the rotating test pieces, circular rods, mainly machined from a welded plate, were used, the diameters selected being 1 in. and ¾ in. These bars, about 3 ft. in length, were attached to a lathe headstock and a pure bending moment in one place was applied by means of two ball races to which known weights were attached. The material of the bar was thus exposed alternately to maximum tension and to equal maximum compression once in each revolution. The machine was run at about 1,060 r.p.m. Bars of identical material were tried in pairs, one specimen welded and the other unwelded, and the number of revolutions before the specimens parted was observed for various ranges of stresses varying from ± 15 tons to ± 6 tons.

In the second series of alternating stress experiments flat plates were used of three thicknesses, viz.: ¼ in., ⅜ in. and ½ in. These specimens were tried in groups of 4, each group consisting of 1 plain, 1 butt welded, 1 lap welded, and 1 lap riveted plate. The specimens, which were about 14 in. long by 5 in. broad, were clamped along the short edges, so that the distance between the fixed lines was 12 in. Each plate was also clamped, near the middle, to the end of a pillar, which by means of a crank arm was caused to oscillate and to bend the specimen equally up and down by adjustable amounts (the maximum total movement in any of the experiments tried was 5/16 in.). The machine was run at various revolutions (not exceeding 90 per minute) and the number of repetitions at which the specimen parted was observed.

Minor tests of various kinds were undertaken, of which the principal had reference to the suitability of the welded material to withstand such bending and shock stresses as might occur in the shipbuilding yards. The experiments on bending consisted of doubling the welded plate over a circular block of diameter equal to three times the plate thickness, and comparing the results with those of the plate of the same material, but unwelded.

In the impact tests heavy weights were dropped from various heights on to the welded portion of a plate 5 ft. in length and 2 ft. 6 in. in breadth, the weld being across the plate parallel to the shorter edge. The deflections were noted and the condition of the weld was examined after each blow.

The chemical and micrographical examination followed the ordinary practice.

**Summary of Experimental Results.**—1. Modulus of elasticity and approximate elastic limit.

(a) In a welded plate the extensions in the region of the weld are sensibly the same as for more distant portions of the unwelded plate.

(b) With small welded specimens containing an appreciable proportion of welded material in the cross-sectional area, the relation between extension and stress is practically the same, up to the elastic limit, as for similar unwelded material.

(c) The elastic limit (or the limiting stress beyond which extension is not approximately directly proportional to stress) appears to be slightly higher in welded than in unwelded material.

(d) The modulus of elasticity of a small test piece, entirely composed of material of the weld, was about 11,700 tons per square inch, as compared with about 13,500 tons for mild steel and about 12,500 tons for wrought iron.

2. Ultimate strength and ultimate elongation.

(a) The ultimate strength of welded material with small specimens was over 100 per cent of the strength of the unwelded steel plate for thicknesses of ½ in., and averaged 90 per cent. for plates of ¾ in. and 1 in. in thickness.

(b) Up to the point of fracture the extensions of the welded specimens are not sensibly different from those of similar unwelded material.

(c) At stresses greater than the elastic limit, the welded material is less ductile than mild steel, and the ultimate elongation of a welded specimen when measured on a length of 8 in., only averages about 10 per cent. as compared with 25 per cent. to 30 per cent. for mild steel.

3. Alternating stresses.
  (a) Rotating specimen (round bar):
    (1) Unwelded turned bars will withstand a very large number of repetitions of stress (exceeding, say, 5,000,000), when the range of stress is not greater than from 10½ tons per square inch tension to 10½ tons per square inch compression.
    (2) Welded bars similarly tested will fail at about the same number of reversals, when the range of stress exceeds ± 6½ tons per square inch.
  (b) Stationary test pieces (flat plate):
    (1) Butt-welded specimens will withstand about 70 per cent. of the number of repetitions which can be borne by an unwelded plate.
    (2) Lap-welded plates can endure over 60 per cent. of the number of alternations necessary to fracture a lap-riveted specimen.

4. Minor tests.

(a) Welded specimens are not capable of being bent (without fracture) over the prescribed radius to more than 80° with ¼-in. plate, reducing to some 20° where the thickness is 1 in. Unwelded material under the same conditions can be bent through 180°.

(b) Welded plates can withstand impact with a considerable degree of success; a ½-in. plate of dimensions already quoted sustained two successive blows of 4 cwt. dropped through 12 ft., giving a deflection of 12 in. on a length of about 4 ft. 6 in. without any signs of fracture in the weld.

5. Chemical and microscopic analysis.
  (a) Chemical analysis.
    (1) The electrode was practically identical with mild steel, but there was a greater percentage of silicon.
    (2) The material of the weld after deposition was ascertained to be practically pure iron, the various other contents being carbon, .03; silicon, .02; phosphorus, .02; and manganese, .04 per cent. respectively.
  (b) Microscopic examination.
    (1) The material of the weld is practically pure iron
    (2) The local effect of heat does not appear largely

to affect the surrounding material, the structure not being much disturbed at about 1-16 of an inch from the edge of the weld. The amount of disturbance is still less in tin plates.

(3) The weld bears little evidence, if any, of the occurrence of oxidation.

(4) With welds made as for these experiments, i. e., with flat horizontal welding, a sound junction is obtained between the plate and the welding material.

6. Strength of welds (large specimens).

(a) Butt welds have a tensile strength varying from 90 per cent. to 95 per cent. of the tensile strength of the unwelded plate.

(b) Lap welds.

(1) With full fillets on both edges the ultimate strength in tension varies from 70 per cent. to 80 per cent. of that of the unwelded material.

(2) With a full fillet on one edge and a single run inferior to those where a full fillet is provided for both edges.

(c) Riveted lap joints: For plates of about ½ in. in thickness, the specimens averaged about 65 per cent. to 70 per cent. of the strength of the unperforated plate.

**Observations of Experimental Results.**—(1) Static elasticity.—It will be observed that the statical tests made to determine the elasticity indicate that, in general, the combination of welded and unwelded material behaves practically homogeneously up to at least the elastic limit. Moreover, the experiments show that the process of welding is such that the stress is distributed practically uniformly over the weld, and also transmitted uniformly to the adjacent plates.

The material of the weld is practically pure iron, and from the tests made on a specimen composed entirely of the deposited material of a weld, it will be seen that for given stress the weld stretches slightly more than mild steel. This property will enable any undue occurrence of load to be transferred in a proper manner to adjacent portions of the structure. When, however, the stress exceeds the elastic limit and is so great that the extension grows continuously without increase of load, the welded material fails sooner than mild steel. This disadvantage is, however, of little practical importance in shipbuilding, and may be regarded as negligible in the particular problem under consideration.

(2) Dynamic elasticity.—In a structure, such as a ship, which is exposed to variations and reversal of stresses, it is extremely important to know whether the material to be used is likely to break down rapidly under such alterations and ranges of stress as are likely to be experienced. The modified Wohler tests employed in the experiments certainly indicate, if considered solely by themselves, that whereas for a given number of alternations mild steel would withstand a range of stress of, say ± 10½ tons, the welded material might be expected to fail at about ± 6½ tons, a figure which is more nearly experienced in ordinary ship construction.

It would appear to be necessary to design the welded joints in such a manner that the amount of work likely to be thrown on the joint is as small as possible, and to meet such a condition a welded joint requires to be either lapped or strapped.

It will be noticed that the material in the weld appears to be nearly pure iron and experiments of repetitive stress show that wrought iron bars are likely to fail under a range of stress of perhaps ± 7 tons to 8 tons, as compared with mild steel at ± 10 tons to 11 tons. The weld has to be deposited electrically and is subject to variations in workmanship; it would consequently be considered satisfactory if the material could withstand a range of stress of, say, ± 6½ tons.

Consideration of the dynamic elasticity of properties appears to show that in any case the welded material can experience as large a number of repetitions of stress as wrought iron could do, and it is always recognized that although iron could not approach the tests for mild steel, yet it was a satisfactory material for shipbuilding purposes. Further, attention to design of detail will increase the performance of the welded joint, and in addition it must not be forgotten that 5,000,000 repetitions of stress is perhaps more than equivalent to 10 years' good sea service.

(3) Physical Nature and Properties.—The welds experimented with are to be regarded as having been produced under most favourable conditions, and that throughout the experiments welds were made with the specimens horizontal and below the operator. In practice, welds will require to be made vertically and overhead as well, consequently, extreme care will be required in such operations

The physical examinations indicate that the materials of the electrode and the system of welding adopted were suitable and reliable. Moreover, there was little apparent oxidation and the material in the neighbourhood of the weld was not affected to any prejudical extent.

(4) Strength of large welds.—Broadly speaking, the tensile strength of butt welds was as great as the unwelded material, but it is considered that greater reliability of workmanship is obtained with joints which are either lapped or strapped.

It was also found that the lapped joint was practically as strong as a riveted lapped joint and would probably remain tight when subjected to more trying conditions than are necessary to disturb a riveted lap joint.

**Tentative Regulations of Technical Committee of Lloyd's for the Application of Electric Arc Welding to Ship Construction.**—(a) System of Welding and Workmanship. 1. The system of welding proposed to be used must be approved and must comply with the regulations and tests laid down by the committee.

2. The process of manufacture of the electrodes must be such as to ensure reliability and uniformity in the finished article.

3. Specimens of the finished electrodes, together with specifications of the nature of the electrodes, must be supplied to the committee for purposes of record.

4. The committee's officers have access to the works where the electrodes are manufactured, and will investigate, from time to time as may be necessary, the process of manufacture to ensure that the electrodes are identical with the approved specimens.

5. Alterations from the process approved for the manufacture of electrodes shall not be made without the consent of the committee.

6. The regulations for the voltage and amperage to be used with each size of electrode, and for the size of electrode to be employed with different thicknesses of material to be joined, are to be approved by the committee.

7. The committee must be satisfied that the operators engaged are specially trained, and are experienced and efficient in the use of the welding system proposed to be employed.

8. Efficient supervisors of proved ability must be provided, and the proportion of supervisors to welders must be submitted for approval.

(b) Details of Construction.

9. The details of construction of the vessel and of the welds are to be submitted for approval.

10. Before welding, the surfaces to be joined must be fitted close to each other and the methods to be adopted for this purpose are to be approved.

11. All butt and edge connections are to be lapped or strapped.

12. With lapped connections the breadths of overlaps of butts and seams and the profiles of the welds are to be in accordance with the following table:—

| [illegible] | [illegible] | [illegible] |
|---|---|---|
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |

Intermediate values may be obtained by direct interpolation, and for thicknesses below .40 the throat thickness is to be about 70 per cent. of the thickness of the plate.

13. A "full weld" extends from the edge of a plate for a distance equal to the thickness of plate to be attached, and

the minimum measurement from the inner edge of plate to the surface of weld is the throat thickness given in the table above.

14. A "light closing weld" is a single run of light welding worked continuously along the edge of the plate. Such a weld may, however, be interrupted where it crosses the connection of another member of the structure.

15. An "intermittent or tack weld" has short lengths of weld which are spaced three times the length of the weld from centre to centre of each short length of weld. Such tack welding may vary in amount of weld between a "full weld" and a "light closing weld."

16. The general character of welds is to be in accordance with the following table:—

| | In-side edge. | Out-side edge. |
|---|---|---|
| (a) Butts of shell, deck and inner bottom plating...... | F | F |
| (b) Butts of longitudinal girders and hatch coamings.. | | |
| (c) Edges of shell, deck and inner bottom plating..... | L | F |
| (d) Butts and edges of bulkhead plating.............. | | |
| | Toe. | Heel. |
| (e) Frames to shell, reverse frames to frames and floors .......... | T | L |
| (f) Beams to decks.......... | | |
| (g) Longitudinal continuous angles.......... | | |
| (h) Side girders, bars to shell, intercostal plates, floors and inner bottom.......... | | |
| (i)) Bulkhead stiffeners .......... | | |

F = full weld. L = light weld. T = tack weld.

17. All bars required to be watertight are to have continuous welding on both flanges with tack welding at heel of bar.

18. The welded connections of beam, frame and other brackets are to be submitted for special consideration.

19. The committee may require, when considered necessary, additional attachment beyond that specified above, and the welding of all other parts is to be to their approval.

As is customary when a new process of construction, of which experience in conditions analogous to those which are met with in ships is not available, is proposed to be adopted in vessels classed by Lloyd's Register, the committee have decided that the classification will be subject to the notation "experimental," and a record of "electrically welded" will also be made in the society's register book.

## Fuel Economy Campaign of British Controller of Coal Mines

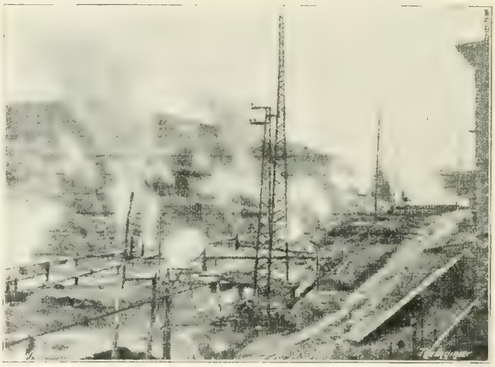
A coal economy campaign was begun last summer by the Controller of Coal Mines. In this work the controller is assisted by a technical staff attached to the head office, and by a large number of engineers in the Provinces attached to the coal control department for this special purpose. This arrangement enabled the country to be mapped out in districts so that all industrial consumers will within a reasonable time be in touch with the organization. The scheme comprises two main sections—(a) electrical undertakings and (b) industrial undertakings. The work involved includes the careful scrutiny of the quantity and quality of coal consumed by the various undertakings and the efficiency obtained. It also includes the inspection of factories and works by experts, in order to ascertain means by which fuel consumption may be reduced and the best methods to that end. Some 400 skilled engineers engaged on this work are giving their services to the Government without salary. Any public body or company or person wishing to effect economies at once and desiring the controller's assistance in this direction communicates with coal-control headquarters, and arrangements are made to send a technical expert to look into the conditions under which coal is being consumed and to co-operate with the consumer in effecting economy. Apart from special applications of this kind, the controller's representatives will visit firms in turn in accordance with a general plan of operations. So imperative is the need to reduce coal consumption to a minimum, states the Government Board of Trade Journal of Aug. 8, that a rationing scheme for all industrial undertakings will be introduced shortly.

## The Development of Electricity by Natural Steam Power Plant

From The Engineer.

The large works at Larderello, Italy, for the recovery of borax from hot springs have long been known. Though the borax industry has been concentrated around this village, the volcanic district for many miles round is punctuated with soffioni — blasts of hot borax-bearing steam which break through the natural crevices of the soil. For many years it was only for the recovery of the borax that this steam was utilized, but of late a new departure has been made which is interesting both for the methods devised for overcoming technical difficulties and for the great importance it may reach.

The earliest experiments for utilizing the Volterra steam for producing power date back to 1903, when Prince Ginori-Conti had a powerful jet of natural steam directed onto the vanes of a water-wheel, but the apparatus was little more than a toy. Later on he used the steam in a reciprocating engine which sufficed to drive a small dynamo and provide current for a few lamps. Encouraged by the development of these experiments, the Prince set up a larger engine of 40-H.P., which also was actuated by the natural steam just as it rose from the ground. The results obtained were satisfactory in a way, but the rapid corrosion of the metal work by the sulphuric acid and other impurities that contaminated the raw steam were a very serious drawback. However, in the hopes that this obstacle might by some device be overcome, several borings were made reaching from a depth of 100 to 180 metres, in which iron tubes, of a bore varying from 20 to 40 centimetres, were fixed. Jets of superheated steam were thus obtained in large quantities. The production of the several shafts varies from 5,000 to 20,000 kilos, of steam per hour, the pressure from 2 to 3 atmospheres, while if the aperture of the tube is completely closed the pressure rises to 4 or 5 atmospheres, and the temperature ranges from 150° to 180°.



Natural Steam Piping at the Central Station.

This source of possible power is clearly important in quantity, and is susceptible of great development, for experience shows that shafts can be sunk as close to each other as are the oil wells in a Pennsylvania field without interfering with their respective production, and the ground in which they can be sunk with good results extends over several square miles. But before this source of power could be made commercially available some means had to be devised for getting over the corrosion of the metals in the apparatus used.

The first attempt on anything like a large scale was made with a jet of 25,000 kilos of steam per hour at a pressure of 2 atmospheres. Theoretically this would provide about 4,000 H.P., 40 per cent. of which could be practically utilized. What was actually done was to install in 1912 a turline of 300 H.P. coupled with an alternator providing a current sufficient for lighting the Larderel establishment. The results obtained were considered good enough to justify the erection of a plant on a larger scale and the huge increase in the cost of coal caused by the war, owing to which coal has been sold on wharves at Genoa up to £20 per ton, provided an additional motive for pushing on the work. Three turbines were built by Tosi, of Legnano, coupled to alternators for the production of 3,000 kw. each. The corrosion problem was tackled in this way. The steam from the soffioni was not sent direct into the turbines but was used to heat three groups of low pressure (1¼ atmosphere) tubular boilers supplied with pure water, the condensed steam being collected for the recovery of the boracic acid and the other by-products which it contains. The boilers which produce the steam for feeding the turbine are vertical and the tubes are of aluminum, as being less affected by the acids contained in the steam which provides the heat for boiling the water in the secondary boiler. Each of these turbines develops about 4,000 H.P., and they are coupled to the three alternators of 3,000 kw. each. The electric current, which by the transformers is raised to 36,000 and 16,000 volts, is distributed by five distinct lines to various towns of Tuscany—Volterra, Massa, Sienna, Leghorn, Florence. Last summer only two of the groups were used, the third being held in reserve, but other turbines were under order, and the power produced will probably be largely increased in the near future. The latest information to hand is that the company has sold more power than it can at present produce. It is in contemplation to provide motor power from this source, in substitution for coal-raised steam, to the two important steel works situated on the coast at Piombino—the Alti Forni and the Magona d'Italia. A scheme of treatment is also under consideration for the recovery of helium and other rare gases, which may be used for the making of electric lamps and other purposes.

Of the economical results of the scheme it is as yet too early to say anything positive. Even if the management were willing to divulge them it is hardly likely that it has yet been able to determine their costs with any accuracy. With coal at its present price almost any source of energy may be scrambled for, but when normal times return the question of finance will assume a different aspect, and the plant now working must therefore still be looked on from the profit and loss point of view, as something of an experiment, though the able men to work it are not lacking in confidence. It will take a longer experience to determine, not only the ultimate efficiency of the plant, but also what will be the cost of repairs for boilers working under the trying conditions to which they are subject. How will this cost compare with that of water turbines?

**Furnace Slag for Pavement Foundation.**—In a discussion of road foundations at the meeting of the Institution of Municipal and County Engineers last June, Mr. E. P. Hooley stated that it was useless to expect to obtain a sound permanent road by laying down 3 in. of permanent facing on a sub-base of 4 in. of round pebbles. He suggested that much could be done even under present conditions to prepare roads for permanent surfacing later on. For this, where the bottom is dry, he recommended the use of furnace slag, broken to 3½-in. to 4-in. gage, having its voids carefully packed with smaller material and well rolled. This, he stated, formed an almost ideal "subcrust" for receiving a permanent face later on, and in the meantime it would carry ordinary traffic well. Where the ground was water-logged he advised the use of faggots laid angle-wise and packed with engine ashes. After well rolling this layer a course of engine ashes or furnace clinker, 4 in. thick, filled in with finer material, and thoroughly rolled, would complete the foundation layer. Faggots were also recommended for use in strengthening of the sides of roadways. This Mr. Hooley effects by excavating the undesirable material and filling in first with a 4-in. layer of rolled clinkers, followed by rolled faggotting laid at an angle of 45° with the line of the roadway. This is surmounted by 4 in. of rolled clinker filled in as already explained.

# The National Laboratory for Industrial Research

BY SIR RICHARD T. GLAZEBROOK

[illegible]

The idea of a laboratory devoted to industrial research is by no means novel, and the steps by which ordinarily a scientific discovery develops into a manufacturing process are generally recognized. First and foremost we have the research student impelled by his thirst for knowledge, his desire to penetrate ever deeper into the mysteries of Nature; he does not work with the deliberate intention of making something of service to humanity. Faraday's discoveries of electromagnetic laws were at first as useless as the new born babe, but had within them that power and potency which has transformed the industry of the world. Röntgen, when he discovered X-rays, or J. J. Thomson when he tracked down ions and corpuscles thought little of their application to surgery and the countless benefits they have brought to suffering humanity.

There must be institutions where research work is carried on for its own sake, where men may make discoveries which may revolutionize and not merely reform the world, where they may train students in those fundamental laws and principles which must be at the root of every successful endeavor to apply science to industry. But there is a wide gap between such homes of science and the works of the manufacturer, and it is to fill this that laboratories of industrial research are needed.

Abbe realized in 1876 that British optical instruments had reached the highest development possible until a radical change was made in the properties of the glass used for lenses; it took years of patient labor, aided by subsidies from the Bavarian Government, before he and Schott were able to place Jena glasses on the market. Von Bayer discovered synthetic indigo about 1880, but it was not until 20 years had passed that the Badische-Anilin-Soda-Fabrik produced it on a commercial scale. Long and patient inquiry was needed in the great laboratory of the General Electric Co., of America, at Schenectady before the Coolidge tube was developed from the original X-ray tube. The work of the discoverer needs development and extension before it can be utilized by industry. This is the task of the Laboratory of Industrial Research.

Or, again, looking at our problem from the opposite side, a manufacturer has some question to solve—the utilization of a waste product which if it were not waste would make all the difference between commercial failure or success, the discovery of a material with some special properties—e. g., a light alloy of great strength at a high temperature—needed before a new machine can be completed. Such a man must have access to a laboratory fitted and equipped for the purpose with a trained staff having stored experience as the result of previous work or researches on cognate questions.

**The Need of Special Laboratories for Research Work.**—But it is sometimes urged: "Why do you need a special laboratory for such work? Can it not be done equally well in one of the university or technical college laboratories? Is it not enough to multiply and organize these, to bring the teachers into direct contact with the manufacturers of their districts, and to encourage the students at an early stage to interest themselves in the scientific problems they will have to solve later in their daily work?" To this my answer would be that it is not enough. The primary work of the professor is to teach and to advance knowledge, that of the student is to learn how to research and to apply his knowledge. The professor will, no doubt, keep in close contact with the industry and take his illustrations from the manufactures of his district, but before his students can usefully engage in industrial research they must have a thorough grasp of the principles underlying all research and of the methods of employing them. Industrial problems are usually too complex for students, and, moreover, the answers are wanted too rapidly to make them subjects of a student's exercise; he will learn by failures; by the inexperienced the right road is only found at last after many tempting tracks leading nowhere have been vainly tried. The manufacturer who comes with a problem which cannot wait will be more sure to find a solution if he applies to men whose daily work it is to attempt such problems and who have the experience of the past to guide them. Moreover, the plant and equipment required is special; the industrial research laboratory must be fitted on the industrial scale. A rolling mill is not an adjunct required in every technical school where the principles of metallurgy are taught, and yet without a rolling mill the study of the light alloys at the National Physical Laboratory could not have been brought to the pitch it has been. The plant and equipment of an industrial research laboratory are provided for the purpose of applying science to industry. The requirements of students and the educational value of the apparatus need not be studied. There must, of course, be many specialized laboratories of industrial research; much more than the National Physical Laboratory is required.

**Future of a Central Laboratory of Industrial Research.**—And now, turning to the future, let us consider what is to be the position of the institution as a Central Laboratory of Industrial Research. In a lecture delivered in Birmingham rather more than a year ago, shortly after Lord Crewe had announced the formation of the Department of Scientific and Industrial Research, I referred to such laboratories, and I wrote:

> There must be more than one; in many cases an industry can be best served by a laboratory near its principal center. Large firms, again, may each prefer to have their own trade secrets—this must be so to some extent—and trade jealousies may interfere with full co-operation, but a private laboratory on a really sufficient scale is expensive; too often it becomes little more than what I have called a works laboratory for testing the products of the factory, and for the smaller firms, at least, the only way to secure the full advantage of scientific advance is by co-operation—co-operation in the laboratory, co-operation, with specialization in production, in the works themselves.

It has been suggested that I wish to make the National Physical Laboratory not merely a national but the only bridge between science and industry. This is not the case; let me quote, in order that I may amplify them, the concluding words of the lecture:

> Associations are to be formed representing various trades or industries; the representatives of these will discuss with representatives of the Advisory Committee, and other experts, questions needing scientific investigation and, when these are determined, the grant, supplemented in most cases by funds raised privately or contributed by the industry, is to be used to carry them out. Such work needs laboratories, and it is here, it seems to me, that the future of the National Physical Laboratory lies.
>
> In many cases, no doubt, the researches contemplated must go on in special laboratories arranged and equipped for the purpose—laboratories closely connected with the industry it is desired to help, situated at the great manufacturing centers; but there are many other researches of wide interest and great importance for which a central laboratory is the proper house, a laboratory fitted and equipped in an ample manner, with a trained and competent staff.
>
> The body controlling industrial science research must have access to a laboratory in which may be studied the many problems which do not require for their elucidation appliances of the more specialized "works" character, or opportunities only to be found in particular localities: where a staff is available, able and experienced, ready to attack under the advice of men skilled in industry, the technical difficulties met in applying new discoveries on a manufacturing scale or to develop ideas which promise future success.
>
> Such a role the National Physical Laboratory should be prepared to play, such is the future which I trust may be in store for it.

This work has already been begun. The various trades associations have been formed, or are being formed, for the promotion of research on matters of interest to the members of the trade.

**Research for Trade Associations.**—The principal objects of an association, as they would be laid down in the memorandum of association, may be briefly summarized thus:

(a) To promote research in connection with the manufacture and use of . . . . by maintaining or subsidizing existing laboratories and workshops, or, if necessary, establishing and equipping laboratories and workshops.

(b) To retain or employ skilled professional or technical advisers in connection with the objects of the association.

(c) To encourage the discovery of, and investigate the merits of, improvements which may seem capable of being utilized for the purpose of the respective industry, and to take out patents or licenses relating to such inventions or improvements and to perfect and develop them.

(d) To support or to establish libraries, collections, or museums necessary for the promotion of the industries concerned.

(e) To publish or to assist in publishing any literature, statistics, or information relating to the subject of . . . that may be of value to members of the association.

(f) To promote in any way desirable the education of those engaged or likely to be engaged in the industries concerned.

(g) To co-operate with other associations or bodies having objects bearing on the work of the association.

(h) To apply to the Government for, and to accept, grants of money and other assistance for the purpose of the objects of the association and to discuss and negotiate with the Department of Scientific and Industrial Research and other Government department's schemes of research and other matters within the objects of the association.

Each such association will probably require its own laboratory situated, for preference, at the center of the trade concerned. This will deal with the special problems of the trade, problems which need intimate association with works conditions for their solution and for which the close supervision of men in works is important.

**Industrial Problems That Can Best Be Dealt With in Central Laboratory.**—But there are numerous industrial problems which can best be dealt with in a central laboratory: let me give some instances of what I mean. Such, for example, are:

(1) Investigations into methods of standardization or of measurement generally.

(2) Investigations into the physical and mechanical properties of materials used in many trades.

(3) Investigations useful to a trade which has no fixed center, but is widespread over the country.

Or, again, (4) a central laboratory will be of service as a means whereby information as to large questions of general interest, investigated either at the central laboratory itself or at the local special laboratories, may be circulated and time saved by placing at the disposal of any special laboratory requiring them the results obtained elsewhere.

**Instances of investigations useful to a trade which has no fixed center.**—A research has been in progress for some time at the laboratory into the heating of buried cables carrying electric currents. In connection with the wiring rules committee of the Institution of Electrical Engineers much has been done to determine the temperature to which the cables used in house wiring are raised in various circumstances, and to fix the safer currents to be used in each case. Our knowledge of the temperature reached in cables when buried in the ground is very scanty and somewhat conflicting; much depends on the nature of the covering used to protect them, and possibly something on the nature of the soil. Cables laid in ducts again differ from those protected merely by the ordinary forms of lead or other covering, and yet the life of the insulation depends in great measure on the temperature reached when the current is flowing and thus regulates the carrying capacity of the cable. Thanks to the co-operation of supply authorities in many parts of the country much valuable information has been collected, and, though the research at the laboratory proceeds but slowly, results of great importance are being obtained. Such a research needs large appliances, and currents up to 8,000 amperes or 10,000 amperes will be employed. It needs also the resources of a fully-equipped physical laboratory in order to measure accurately the temperature differences due to varying conditions; when complete it will be of value to all supply companies. This is true of many other electrical tests and experiments; the results are of wide application; it is desirable that they should be widely published.

The building trade offers another example of this kind. Brick and stone, wood and iron, have been used for long, and their properties when employed for building construction are generally well known. This is less true of other more modern materials—ferro-concrete, for example. There are rules—based no doubt on the best experience available—for estimating the strength of beams, columns and floors, but there is much scope for inquiry. Accordingly, at the instance of Sir John Cowan, of the firm of Messrs. Redpath, Brown and Co., who is bearing the expense, apparatus is being built to test columns up to 15 ft. or 20 ft. in length and floors of considerable size. War conditions again are interfering, but the work is progressing slowly and must be done. There are other materials besides ferro-concrete urgently calling for examination. Nor is the strength of the materials the only factor to be considered. Materials transmit heat in very varying amounts and the comfort of a house, to say nothing of the cost of living in it, will depend on whether it is possible easily to keep it warm in winter, cool in summer. Recently we were asked to compare the heat losses from two enclosures exactly alike in all respects, except that the one was roofed with corrugated iron, the other with some preparation of asbestos. It was found that the latter cooled 20 per cent faster than the former; the loss of heat depends, in part, on the conductivity of the material, in part on the emissivity of its surface, and the superior emissivity of the asbestos sheet more than made up for its inferior conductivity. In this connection it is clear there is much to be done, and for such work a central laboratory, with proper equipment, is the most suitable place. Arrangements are in progress by which it is hoped many of these questions will be thoroughly investigated.

The importance of the collection and dissemination of information on matters connecting industry and science is clear. At a central laboratory much of the information will be to hand; the accumulated experience of the staff, their knowledge of the work done in the sectional laboratories, their appreciation of the bearing on industry of inquiries in the region of pure science, are all valuable assets and a proper organization only is needed—by means of a bulletin or in some such way—to circulate their information where it is most wanted.

There is ample room for a central laboratory without trenching in the least on the spheres of the local sectional institutions. If the Department of Scientific and Industrial Research is to carry out effectively the work it contemplates such a laboratory is essential, and my hope is that the National Physical Laboratory may develop into such an institution in close connection, through the department, with local laboratories throughout the country.

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## Provisional Plans for Draining the Zuider Zee

From the Engineering Supplement of the London Times

The announcement that the necessary authority has been given by the Dutch Parliament for the draining of the Zuider Zee probably brings ambitions which engineers have entertained for a very long period a stage nearer realization. The area with which it is proposed to deal is one of nearly 1,500 square miles, of which over 800 would be reclaimed and the remainder converted into a fresh water lake, thus providing a remedy for the present dearth in Holland of water supplies in summer. From the point of view of the engineer the reclamation, on which it is proposed to expend 15¾ million pounds, is a large-scale project of somewhat simple form. The construction of a main embankment over 18 miles long, which it is estimated would occupy nine years in construction, would shut out the sea, and enable four areas extending over 500,000 acres to be set aside for reclamation. These would probably be available for occupation within 20 years, by which time the ordinary reclamation schemes in Holland, which have provided about 25,000 acres annually for a considerable period, will from natural causes have been discontinued.

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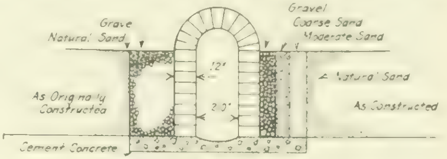
## Pumping Experiments for Subsoil Water Supply for Puri

From Indian Engineering

An interesting report on some pumping experiments at Puri in connection with water-supply of that seaside town has been made by Mr. F. C. Temple, Sanitary Engineer to the Government of Bilhar and Orissa. The supply is being sought for in a somewhat novel direction and it is chiefly this that lends interest to the scheme. It had always been understood that the sandy tract running parallel to the sea contained a good supply of fresh sub-soil water, but until Mr. Temple took in hand definite experiments to prove it the sufficiency of the supply for the purposes of a complete water-supply project remained uncertain.

Mr. G. B. Williams, Sanitary Engineer, Bengal, after making some deep borings, ascertained that sub-soil water existed with a surface fall of about 1 in 1,000 and suggested that this water might be intercepted by means of an infiltration gallery. It then remained to determine what length of gallery would be required to intercept all the water required for a water-supply to the town. Mr. Williams had selected a site (about 1 mile from Bay of Bengal) for the gallery. A length of gallery 20 ft. long had been constructed, a pipe had been led from the gallery to a well, and a suction pipe for the pump had been fixed in the well. But all this had disappeared in the sand when Mr. Temple took up the subsequent experiment; and it became necessary to recover and repair the works. The gallery was patched up, the suction well was reconstructed and the pipe connecting gallery and well was rejected in favor of a continuation of the gallery right up to the well, thus making its new length 36.5 ft. The pump delivered into a 9-in. pipe which discharged the water 2,220 ft. away through a gage tank on the high bank of the sea. Observation pits were also established at intervals.



Section of Infiltration Gallery.

Unfortunately, some delay occurred in having everything ready for conducting the experiments in the hot weather of 1916, and so pumping began after rain had fallen and raised the level of the sub-soil water. Two Worthington pumps were employed, one 6 in. x 8½ in. x 6 in. and one 6 in. x 5¾ in. x 6 in., and they worked continuously from the 5th to the 30th of July, a rate being maintained that kept the level of the water 1 ft. above the invert of the gallery. On July 19 a decided fall was observed in the observation pits out to 300 ft. from the trench and four more pits were dug. On July 30 the pumps were speeded up and the gallery bed was kept as nearly dry as possible. The pumps were stopped at 10 a. m. and recoupment observations taken. The total quantity of water pumped worked out to 9,710,085 gal., or an average of 388,403 gal. per day; that is, 443 gal. per hour per lineal foot of gallery. The inflow to the gallery was perceptible up to a radius of rather more than 500 ft. or an area of some 800,000 sq. ft.

While the experiment was going on 10.86 in. of rain fell on this area representing 4,000,000 gal. or more than one-third of the total quantity pumped out during the test. And this fact, of course, prevents making the straightforward use of the pumping figures that could have been done were the figures obtained for the driest period of the year. The fact has, however, been established that the perimeter of sand influencing the gallery, when the radius of inflow is 500 ft. was 500 × 2 × 3.142 + 2 × 36.5 = 3,215 ft.; and taking the average depth from the surface of the water to the floor of the gallery as 5 ft. that the area of sand through which infiltration took place was 3,215 × 5 = 16,075 sq. ft. As the average discharge of water for the last three days of the test was 458,000 gal. per day we have 16,075 sq. ft. of vertical sand surface discharging 458,000 gal. of water per day; that is, a discharge of 458,000 ÷ 16,075 = 28.5 gal. per square foot per day. In order to double the discharge we should have to double the vertical surface area of the sand through which the water filters, and this can be done only by lengthening the gallery. The perimeter which before was 3,215 ft. must now be 6,430 ft., consequently the length of gallery must be increased from 36.5 ft. to 1,644 ft., but here two practical considerations come in. First, we must reject the wholesale face of the gallery as not really to be depended on for contributing to the inflow; and, second, we have to consider not the depth of water in the gallery at the time of the experiment, but the dry season depth, which Mr. Temple takes to be 2.8 ft. This latter consideration alone will reduce the discharge in the ratio of 1 to 0.53, and hence the yield becomes only 242,740 gal. per day, or 15.2 gal. per sq. ft. per day.

The population of Puri is about 40,000, which at mela times may be augmented to 150,000. An allowance of 20 gal. per head ought to be allowed for requiring 800,000 gal., or roundly 1,000,000 gal. per day to be pumped in 16 hours; at mela times, by pumping for 24 hours, perhaps 1,500,000 gal. daily could be obtained. Mr. Temple thinks 10 a safer figure than 15.2 on a consideration of the extremely slow movement towards the sea of the table of sub-soil water which is probably only about 1½ ft. a day. For 1,000,000 gal. therefore the area necessary is 100,000 sq. ft. the perimeter of this area would be 33,333 ft. and the straight length of 28,306 ft. or about 5 miles. The sandy stretch extends for 10 miles or more and is an open site about a mile wide, so that there is every probability of the supply being sufficient at all times. An analyzed sample of the water did not prove to be quite as favorable as was expected, but there is little doubt that if the area be taken over it can be kept free from pollution.

## Shaft Sinking by Freezing Process

The freezing process was successfully employed in sinking two shafts through water bearing ground at the Llay Hall Colliery, Wrexham, England. The method employed was described in The Engineer. Two foreshafts were sunk 12 ft. deep and 31 ft. in diameter and lined with brickwork. Concrete was placed on the bottom after inserting straight vertical guide tubes for 25 bore holes distributed around a circle 26½ ft. in diameter. In the upper strata the holes for the freezing tubes were bored by the rope method, but in the lower and harder ground percussion apparatus operated by a steam cylinder was used. The cold necessary for freezing the water-bearing ground was applied by two distinct groups of machines. The pipes and valves were arranged so that either group of machines could operate on either shaft or on both simultaneously. Each included a belt-driven ammonia compressor with an independent horizontal steam engine having cylinders 16¾ in. in diameter and 30-in. stroke. A solution of calcium chloride was used as the freezing liquid and was caused to circulate between the refrigerators and the freezing tubes by means of two plunger pumps. The brine pipe between plant and shaft was insulated with hair felt. The ground was frozen to a depth of 231 ft. in the first and 235 ft. in the second shaft. The diameter of the pit shafts after lining is 18 ft.

**Use of Refuse Destructor Clinker in Road Work.**—At a meeting of the Institution of Municipal and County Engineers last June several surveyors reported that they had obtained good results in the use of tarred clinker for street and road work. Mr. G. Green, M.I.C.E., of Wolverhampton, stated he had used it under very trying conditions in that borough. It was first tried for a short and narrow roadway, where the wear and tear on the waterbound macadam previously adopted had been excessive. The carriage way here is 20 ft. wide and the clinker Mexphalte was deposited in two layers. The under layer was 3 in. thick and the top coat or carpet 1 in. thick. The cost was 8s. 7d. ($2.06) per square yard, and the work has, it was stated, proved very successful.

## Method of Steel Ship Construction at Greenock Yards

From Engineering.

A considerable time ago the Greenock & Grangemouth Co., Ltd., introduced into its works a system of preparing material direct from the De Bergue multiple punch.

In the yard at Greenock, 75 per cent of the outside plates of the ship are prepared and punched without any templating. If these plates could be obtained the proper width from the steel works, no handling would be required by skilled workmen, except when the plates were being screwed up in place. Even this work could be done under the supervision of one experienced man.

The procedure is as follows: Plates are brought into the yard from the railway, rolled through the straightening machines and put in piles until they are required. The plates are then taken in rotation to the machine, marked with a batten the length of the plates and spacings of frames. This is all done off an ordinary expansion plan of plating. The punches are set in the machine to suit the right spacing of the holes required for the particular part of the ship. The question of the spacing of the rivet holes to suit the machine has been raised with the classification societies, and permission was given to make the alterations necessary to suit either longitudinal or ordinary transverse work. The changing of punches is therefore reduced to a minimum.

The firm orders as many plates of the one length and breadth as possible, so that time is saved when punching is commenced. All the parallel plates can be done at one shift. They are then lifted from the multiple punch by an hydraulic crane and landed at the scarphing machine. From thence they are removed to the vertical machine by the same crane. They are then countersunk and lifted by a crane to the planing machine. As they are all straightened, there is nothing to do but to take the plates direct to the building berth. The bottom shell plates are erected before there are any frames or floors put up. It is found more economical to put the shell plates up in place before any floors or frame shell longitudinals are erected. The floor plates and longitudinals are then lifted up and bolted to the shell plates. The bilge plates are punched from the multiple punch, set to the curve and erected immediately the floor plates are put up in place, thus completing all the bottom plating to the upper turn of the bilge before any of the frame legs are erected.

The tank top plates are punched immediately the bottom shell plates are finished, so that when the floors and longitudinals are fixed in place to the shell, the tank top plates are immediately put up and everything fixed in place. The bottom of the ship and tank top are thus plated in a very short time. Here, again, little or no templating or mould making is required. The tank top plates and side shell plates are finished so far as the automatic machine is concerned. Punching of the decks is commenced immediately, and they are prepared for erection as soon as the beams are put up. No ribbanding is necessary for the framing, shell or deck plates, the stringer plates bringing everything fair. All the plates are run parallel to the center line and the edges of the plates up the side are treated as waterlines. There is a curve on the edge of plates at the end of the vessel only, so that by the adoption of this method the greater number of plates are punched by the machine. The firm has framed and fitted the side plating for 260 ft. of a 420-ft. vessel up to the sheer strake within eight days. They commence framing the vessel amidships so that all the frames and midship shell plates are erected simultaneously and the center part of the vessel is practically completed while the frame setters are setting the end frames of the ship, thus saving considerable time in construction, and shortening the time the vessel is on the building berth. On this system, with the aid of pneumatic riveting—of which they have a large installation at Greenock—ships can be built quickly, especially if there were freedom of labor as in America. Men can easily put in with pneumatic riveting 600 to 700 shell rivets per day; but the number has been reduced to that which can be put in by hand. This is an example of restriction of out-pat. The Greenock Grangemouth Co. has proved that by the adoption of their system ships can be erected in two to three months less than the time taken to construct vessels on the ordinary system.

## Structural Engineering

From an editorial in Engineering

It is not many years since that an eminent American bridge engineer denounced the plate girder as the most unscientific of all bridge structures, whilst another applied the same opprobious epithet to the Forth Bridge on its completion. In both cases the underlying assumption made was that to estimate the safety of a structure it was necessary to be in a position to evaluate with accuracy the maximum stress carried at any point. In a very interesting and suggestive paper recently published in the Revue Generale des Sciences, M. Charles Rabut, formerly engenieur de la construction au Chemin de fer de l'Ouest, seems to accept this contention as correct, but maintains most strenuously that the usual methods adopted for determining such stresses are invariably grossly in error. The assumptions necessary to make feasible the computation of stresses in complicated structures, are, he observes, far from being satisfied in practice. On this point M. Rabut is able to speak with indisputable authority. Over a period of many years he made innumerable measurements of the actual stresses attained in different bridges belonging to the Western of France Railway, and compared his observations with the values of the stresses as computed on the ordinary assumptions. He found that in web members the measured stress had often three times the computed value, and it was seldom less than twice as great. On the other hand, he found the stresses on the flanges and chords of main trusses were often markedly less than the computed values, and it was thus possible to maintain in service a number of bridges which the average computer would have condemned as greatly over-strained. In fact, Hennibique's principle that every part of a bridge forms in actual fact part of the main truss, is as applicable to ordinary steel structures as to the ferro-concrete monoliths for which it was devised. Thus the floor of a bridge commonly adds considerably to the flange strength of the trusses. For example, when it was proposed to lengthen the bridge which carries the Rue Legendre over the tracks of the Western railway in Paris, a measurement of the stresses on the bridge showed that this effect of the roadway had most materially reduced the flange stresses below their calculated values. M. Rabut was able accordingly to lengthen the original girders by no less than 8 m., increasing the span from 40 to 48 metres, without having either to reconstruct them or to strengthen them.

American bridge engineers have also recognised this effect of the floor, but in place of utilising it in order to increase the factor of safety of the structure, they, in several cases in the past, adopted the extraordinary expedient of cutting the floor up into a series of independent lengths in order to eliminate any reinforcing effect it might have on the effective strength of the trusses. In this way a closer relationship between the actual and the computed stresses was retained (a consummation much desired by the older school of American bridge designers), but at a considerable, if not easily evaluated, reduction in the real factor of safety. In some more recent large bridges such as that over the Ohio River at Sciotoville, however, the more scientific plan of making the floor continuous has been followed.

As already observed, M. Rabut appears to accept the view that the maximum stress on a structure is the measure of its effective strength. He merely differs from German engineers and the older school of American bridge engineers in maintaining that these stresses should be measured rather than computed. Undoubtedly this policy is an improvement on its rival, but it is at the same time quite certain that the maximum stress, even if experimentally determined, is by no means necessarily a measure of the safety of a structure. It is quite easy to devise a structure in which the maximum stress is double that in an alternative design, and yet, although the materials used are of the same kind and quality, the factor of safety may be two or three times as great as that of the structure with the lower stress.

M. Rabut, in view of his observations on the actual stresses in the web members of a truss, advocates the complete abandonment of the ordinary type of triangulated truss in favour of the Vierendeel system, in which actual experiment has shown a much closer accord between the calculated and the actual stresses than is found to exist in the usual types of triangulated trusses. Any expression of opinion by M. Rabut is entitled to very serious consideration, as not only does he stand pre-eminent amongst those who have made a study of the actual stresses in steel structures, but he has also been the responsible designer of a number of important bridges, some of which have been at once remarkably bold and perfectly successful. Nevertheless, his verdict in favour of the Vierendeel type seems open to criticism. The fact that calculation and observation agree seems no means conclusive as to the superiority of the Vierendeel system. In fact, as James Thomson pointed out seventy years ago,* it is in many cases not the maximum stress on a structure, but the range of stress which constitutes the measure of its safety. This range of stress is proportional to the live load, and is generally independent of such internal stresses as may arise from the fact that joints are rigid and not flexible as assumed for the purposes of calculation. It is perhaps questionable whether any structure has ever failed because a compression member (in place of being free at the ends, as assumed for the purpose of calculation) was actually firmly fixed at its end to adjoining members. In fact, in most cases this fixation in place of reducing the ultimate resistance of a strut (owing to the bending moments developed) will actually increase it. It is thus, to say the least, doubtful, if in actual practice a Vierendeel truss will show as high a service strength as a well-designed triangulated truss of equal weight. A secondary stress, it should be observed, is one which is capable of relieving itself by a local permanent yield of the material. Such a yield will not generally compromise in any way the safety of the structure as a whole, at any rate, so long as the stress is not alternating in character. Even in this latter case, moreover, though a local crack may develop and give trouble, it will seldom involve any immediate danger to the stability of the structure as a whole.

M. Rabut criticises as irrational the practice of the Government departments of all countries in specifying the safe loading for structures, not on the basis of the actual stresses, but on the stresses as calculated in the conventional way on premises which are in many cases demonstrably wrong. Possibly, however, this practice is more defensible than would appear from this presentation of the facts. Very few experiments, for example, have been made on the actual stresses in ship structures, yet ships of new types and sizes have been satisfactorily proportioned by just such a process as M. Rabut condemns. A ship is taken which has proved satisfactory in service. It is assumed to rest on the crest of a wave of a length equal to that of the ship and the stresses on the structure calculated on this basis. The new ship is then proportioned to have no higher stresses when exposed to a precisely similar arbitrary loading. No doubt as time goes on some accurate data as to actual stresses in service at sea will be accumulated, but even such knowledge obtained by "ausculting" ships as M. Rabut has ausculted bridges will hardly make it possible to avoid the use of an arbitrary conventional load in estimating the scantlings for a new type. The case of a motor-car axle is still more difficult. Should official rules ever be promulgated for these, they must necessarily be arbitrary in character as no one knows, and it seems hardly practicable to determine, what the actual stresses are in

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such axles when a car is driven at high speed over a rough road. All that it is practicable to do is to calculate on certain arbitrary and necessarily inaccurate assumptions the stresses on an axle which has proved adequate in service, and then to proportion other axles to have no greater stress, as calculated on the same conventional and inaccurate bases. Hence the official rules and regulations for bridges may be quite defensible if considered simply as a means for the comparison of a proposed new structure with others which have given good service in the past. Of course, the objection does lie that the new structures may depart widely in details from those with which the comparison is thus made, and to this extent the procedure is certainly defective.

In this connection M. Rabut states that a very important step forward has been made by the French Ministry of Public Works. Whilst the existing regulations as to calculated stresses are not abrogated, the department announced in 1916 that these rules would not be enforced in cases where bridge engineers were able to justify their designs by direct experiment. This is a very bold step for a beaurocracy to take, and it is to be hoped that the usual desire in all countries of Government officials to evade responsibility will not soon render the concession a dead letter. This would certainly be its fate in this country, if we may judge from the record of the Board of Trade in regard to the provision of life-saving appliances at sea. When certain regulations were first published it was announced that where the shipowner made special provisions of another kind, certain of the specified requirements might be relaxed. It was given in evidence before the Titanic inquiry commission that the department had never once allowed a shipbuilder to take advantage of this clause, however much he might have added to the safety of crew and passengers by exceeding the Board's requirements in other directions.

M. Rabut anticipates a vast extension in the employment of reinforced concrete. In fact, he maintains that for bridges of spans less than that for which the suspension bridge becomes advisable the concrete bridge will supersede steel, and even in the case of suspension bridges ferroconcrete may, he suggests, be used for the roadway and stiffening girders. Already one concrete bridge has been built in France, with a radius for the arch of 130 m. (426 ft.), the span being 96 m. (315 ft.). In this case the effect of the sprandrels in adding to the strength of the arch was taken into account, the results of the troublesome and tedious calculations being checked by studying a glass model of the structure by means of polarised light, a method of stress determination first suggested by Sir David Brewster. This method, it is interesting to note, is now being somewhat extensively employed in this country for evaluating the stresses in certain complicated structures.

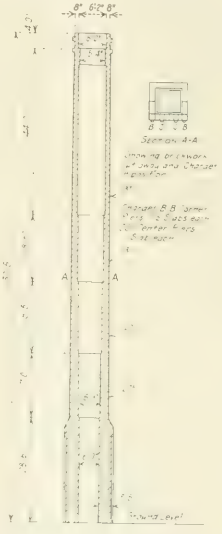
One objection to the rigid arch is, of course, the troublesome character of the calculations if made in the ordinary way. One method of diminishing this trouble is to fix definitely the value and position of the thrust at the crown by means of jacks. In this way the thrust can be regulated so as to adjust the stresses exactly as desired. This plan has, M. Rabut states, been adopted in France by Freyssinet, and it has also, we may add, been used in Canada.

In this connection we may perhaps call attention to an important paper by Mr. J. A. L. Waddell, published in the March issue of the Journal of the American Society of Civil Engineers. In this paper Mr. Waddell gives the results of an exhaustive and most laborious inquiry into the economics of steel arch bridges, comparing the relative weights of arches with three hinges, with two hinges and with no hinges, for spans ranging from 100 ft. up to 2,500 ft. On the assumptions made he finds that the three-hinged arch is a little heavier than the two-hinged, but is nearly always lighter than the hingeless type. No doubt this result is correct on the assumptions made, but it is quite probable that in actual fact the superiority really lies with the rigid structure since, as we have already observed, stress is not always a certain criterion of strength. The less statically determinate the structure the less conclusive is the stress criterion as a measure of its safety.

# Method of Felling a 130 Ft. Factory Chimney

From Royal Engineers' Journal.

A factory chimney was very badly cracked on all sides and for all the upper portion of its height. Some of the cracks had been filled fairly recently with cement mortar, and in all such cases the bricks had still further opened showing that the decay which had set in, had not been arrested. The traffic in the neighborhood had increased; heavy motor lorries on the adjacent road, and a new broad gauge railway passing the entrance to the yard set up considerable vibrations and earth tremors; it was consequently considered advisable to fell the chimney and so obviate any chance of it coming down unexpectedly.



Sketch Showing Location of Charge.

The only clear ground on to which the chimney could be felled was in the direction of the entrance to the yards, and even on this line there was not sufficient length to throw the whole height of the stack in one operation; the yard entrance had buildings on either side and the clear gap between these buildings was only about 35 ft. It was consequently decided to fell the top 66 ft. 6 in. as a first measure, and the chimney—the total height of which was 130 ft. 6 in.—was prepared for demolition as shown on the attached sketch.

Foot irons were in existence on the inside of the chimney, and a stage was fixed inside just below the point marked "A-A," three holes about 15 in. high were cut in the wall on the side on which it was intended to throw the chimney, and openings also about 15 in. high were made on each adjacent side wall. The four brick pillars (the corner pillars each 18 in. square and the two intermediate pillars 15 in. x 18 in.) left by this operation, were calculated to carry half the brickwork above them with a factor of safety of four, the other half being carried on the back wall and the remainding portions of the side walls.

The charges were guncotton, and were calculated at half the amount laid down in the Field Service Pocket Book, it being considered sufficient to make the brick pillars fall and crumble and not necessary to blow them completely out. A heavy explosion might have caused the chimney to collapse in its vertical position, and for this reason the charges were placed outside the chimney thus avoiding any of the gases produced by the explosion causing undue pressure inside the shaft.

In order to lay the charges in the position shown B, B, C and C, a light platform was fixed outside the chimney on cantilever bulks pushed through the holes which had already been made, and the officer laying the charges crawling out through one of these holes. Just before the charges were fired the openings in the side walls were continued towards the back wall until each extended to a point 3 in. over the center line of the chimney; this was done to ensure the stack falling as soon as the pillars in the front wall failed. The charges were fired electrically, the leads being carried to an exploder some 100 yards to the flank.

Immediately after the explosion occurred the chimney started to lean over in the required direction, and it was not until it had gone over about 20° that a large piece slid off the back wall, and smashed in one side of the issue room roof—this was expected. The chimney fell in the space between two buildings and except for a hole about

3 ft. sq. in the weather-boarded wall of one of them no damage was done.

## Sewage Disposal of London by Sludge Ships

From a paper "Main Drainage of London," by Mr. George Walter Humphreys, in Minutes Proceedings of Institution of Civil Engineers, Vol. CCIV.

Specially designed ships have been employed since 1887 for conveying sludge from the sewage works of London and disposing of it at sea. The first of these vessels was placed in service in 1887, the second in 1889, three more in 1892 and the sixth in 1895. The sludge is precipitated at works at Crossness and Barking. The contract was let in 1887 for the construction of about 8¾ acres of precipitation tanks at Barking. Simultaneously, at Crossness, works were undertaken whereby the old reservoirs were converted into tanks, and additional reservoirs were built, affording a combined area of about 9½ acres of precipitation tanks. The various accessory works—sludge channels, pumps, machinery for treating and mixing chemicals, and quarters for the staff of workmen to be employed—were executed at the same time. On the advice of Mr. W. J. Dibdin, the chemist of the Metropolitan Board of Works, lime and proto-sulphate of iron in the proportion of about 4 grains and 1 grain respectively to 1 gal. of sewage were the chemicals chosen. Partial precipitation commenced in 1890 and precipitation of all the sewages was obtained in 1892. The works were designed to work on the intermittent system, but in 1891, by the simple addition of weir walls in the tanks, continuous precipitate was effected, by which the quantity of sludge was immediately increased nearly threefold.

All the sludge-vessels constructed and put into use over the period 1887 to 1895 are running constantly on the service at the present day. The machinery of the oldest is in need of renewal; but for the war this would have been undertaken, when a further long period of usefulness would be before it. The discharging ground was originally the Barrow Deep in the Thames Estuary. In 1906 this was altered to the Black Deep, where there are soundings of 10 fathoms, and over at L.W.O.S.T. The distance from the Barking Sewage Works is 52½ nautical miles to the extreme limit, and the sludge is discharged while steaming over an area about 4½ miles long and 2½ miles broad. The run from the outfalls to the discharging ground and back takes about 10 hours. The ships leave on the top of the flood-tide, having thus the advantage of the ebbing tide under them and the incoming flood on the return journey, the discharge being usually accomplished about 1 hour before low water. By these means 20 or 21 trips are usually made by each vessel each fortnight when running. The cargo carried is 1,000 tons, containing an average of 92 per cent of water. During the 10 years ending March 31, 1914, the cost of working alone averaged 3.8d. (7.6 ct.), or including capital charges 4.4d. (8.8 ct.) per ton during this period. The capital charges on the existing vessels are nearly extinguished, their cost being amortized in 25 years. Certainly by no other means could a less costly method of handling a ton of liquid sludge, with such complete immunity from prejudicial results, be attained. The cost of precipitation or treatment, excluding capital charges, over the 10-year period ending March 31, 1914, has varied between £1 6s. 7d. and £1 0s. 2d. per 1,000,000 gal. of sewage, the average being £1 3s. 4d. ($5.66) per 1,000,000 gal., capital charges included.

**First Concrete Vessel Built in China.**—The small reinforced concrete vessel Concrete, the first ship of its kind built in China, made its trial trip Aug. 22. The boat has two 4-cylinder, 4-cycle motors of 30 HP. each, and according to Shipping and Engineering made a speed of about 8 knots and went through the water with a clean entrance and a total absence of vibration, the engines working at 500 revolutions per minute. There was no sign of weeping inside the hull, the timbers being as dry and dusty as if the vessel had not left the stocks.

## The Work of Women in Engineering Factories

[illegible] H. [illegible] Institution of [illegible]

There is no doubt that war experience with women in industrial works has entirely destroyed all preconceived ideas as to what constituted "skilled work." Previous to the outbreak of war fully skilled men were regularly employed on work which can now be performed by women after a few weeks' training. It is not that the woman is a skilled worker, but has been put to a job which is a subdivision of skilled work on which a fully skilled man was previously employed.

The assumption that is so often made that women become fully skilled workers in a few weeks is quite a false one. We can speed up the training of engineers by better teaching and apprenticing, but in the author's opinion, neither a man nor a woman can become a fully skilled fitter or turner under a period of, say, four years. On the other hand, war conditions have enabled women to acquire a measure of skill in a far quicker time than men have ever previously acquired it. This is partly due to the patriotic desire of the women to assist in the war, and principally to intensive shop teaching under manufacturing conditions as opposed to go-as-you-please academic training and drifting through works under pre-war apprenticeship conditions.

Women have generally been found to be accurate and conscientious workers. They acquire a high degree of accuracy quicker than men through possessing a finer sense of touch. It has also been demonstrated that women are highly responsible workers; i. e., that they can carry out with confidence finishing processes on large and costly work, and can manipulate high speed and heavy machinery in the operation of which there is a certain measure of risk, such as driving large cranes. Women are specially suitable for such skilled and semi-skilled occupations as tracing, drafting, marking off the lighter work of all kinds and acetylene welding, while they are capable of acquiring a high degree of skill on subdivisions of accurate toolroom work in turning, milling, grinding and fitting operations.

Generally speaking, women may be said to have excelled in machining work rather than in fitting work. It is a peculiar fact that while women do not easily tire of machining operations with consistent repetition, they do stale on repetition fitting work, and quite a large proportion of them do not find the work sufficently interesting to induce them to complete their initial training.

With regard to the employment of women on heavy manufacturing work there is a great deal of misapprehension. It is not generally understood that women can safely handle, in the course of machining and fitting operations, pieces weighing up to 60 lb. and can also manipulate almost as well as men, with the aid of lifting appliances, any weights over 80 lb. It is on work weighing between 60 and 80 lb. where it becomes questionable whether women can be properly and economically employed. There is the cost of special lifting tackle and handling devices necessary for women that may be obviated in the case of men, and in instances where tackle has been provided for dealing with these weights it has been found that women prefer not to go to the trouble of using such tackle and so overtax their strength by endeavoring to lift weights, which after a time generally results in injury to health. In regard to output, women workers have enormously increased the records of output of all products of a repetition character which were current in munition firms previous to the war, but on non-repetition work it is doubtful whether they have, generally speaking, equalled the output of men.

As an example of increase of output obtained by women as compared with skilled men on repetition work even of a heavy nature, the author may cite the case of a factory making 9.2-in. shell. The practice in this factory was to bore the shell in three operations, and the total time taken for the complete boring by skilled men was 3.16 machine hours. Women were substituted for men on the boring lathes, and after one week's practice were able to do the work in an average time of 3.6 hours. In less than three months they had reduced the average time to 1.25 hours, thus increasing the output to two and one-half times its previous figure. Scores of similar instances might be quoted.

It is an important point in the employment of women operatives in manufacturing work that they should be managed as far as practicable by women. If possible, women tool setters and setter-up should be employed, also women charge-hands, sectional forewomen, and wherever possible women supervisors and shop managers.

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## Women Labor on Heavy Construction Work

Women labor was used extensively last spring in the construction of an 8-berth shipyard on the northwest coast of England. They charged the concrete mixers, laid and ballasted the rail of railway tracks, filled low ground, excavated the site of the wet dock, and in fact undertook all kinds of work which hitherto has been considered unsuitable for their sex. The accompanying photographs, reproduced from Engineering, shows the women engaged in pick and shovel work. It is stated that the women worked with hearty good will but were not as efficient as the male navvy. At first there were many cases of sprained ankles among the women, due to their working in high heeled boots and shoes. A standard boot was designed by the officials and this trouble was eliminated.

Women Navvies Excavating for Wet Basin.

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**Water Supply on the Western Front.**—Water for the Allied Forces on the Continent is mostly obtained from wells, states Water and Water Engineering. The British territory is underlaid with chalk; driven wells, therefore, have to be sunk, approximately from 150 ft. to 250 ft. to reach the water-bearing level. With two shifts the drilling progress on a 6-in. hole varies from 20 ft. to 60 ft. a day, and the yield per well ranges from 50 to 150 gal. per minute. In the Somme Valley British troops use river water, which is passed through purification plants, mounted on barges. About four-fifths of the French Army water supply in the region of Verdun is obtained from wells. Wells dug by hand, in addition to drilled wells, are employed to some extent—one of them being put down 65 ft. If time permits, these dug wells are lined for the upper 10 ft. or 12 ft., and a kerb 2 ft. high is built around the top to prevent debris or waste water falling back into the well. For dug wells a round section about 4 ft. in diameter is common.

# Standard Specifications for Cast Iron Pipes for Water and Gas Mains

From a report submitted May 21, 1917, to the Institution of Water Engineers (formerly British Association of Waterworks Engineers), Transactions of the Institution, Vol. XXII, 1917.

**Range of Standards.**—Socket and spigot pipes, with both plain and turned-and-bored joints, have been standardized up to 48 in. diameter, in lengths of 8 ft. from 3 in. to 12 in. diameter, and lengths of 12 ft. from 4 in. to 48 in. diameter. Flanged pipes and special castings have not been standardized above 24 in. diameter as the demand for such is very limited and the conditions under which they are to be used frequently call for special designs.

**Division Into Classes.**—There are to be 4 classes of pipes, A, B, C and D, varying in thickness to withstand the respective test pressures of 200, 400, 600 and 800 ft. head of water, while it is recommended that the working pressure shall not exceed one-half of the test pressures.

Class A pipes are only intended for gas or other purposes where the working pressures are low.

The special castings have been divided into two classes only, so designed that one pattern suits Classes A and B pipes, and the other, Classes C and D pipes. By this means the number of standards for specials has been halved.

**Jointing-Up Pipes of Different Classes.**—The standards have been so designed that pipes and specials of all classes up to 10 in. diameter can be jointed together and leave a sufficient lead space for caulking. Above 10 in. diameter the pipes of Classes A and B can be interchanged, as also can those of Classes C and D.

**Constancy of External Diameter.**—In order to render the pipes and castings interchangeable it was necessary to standardize the external diameter and allow the internal diameter to vary slightly with the thickness and describe it as the nominal diameter or bore. This has had the effect of enormously reducing the number of patterns, as those for the barrel and socket, of any group, remain the same throughout.

The variations are really trifling, thus a pipe of 3 in. nominal bore may vary between 3.00 in. and 2.96 in. diameter and a 48-in. pipe between 48.00 in. and 48.44 in. diameter according to its thickness or class. In practice this can have no measurable or important effect as, in the first place, it has not been the practice to split inches of diameter, and, in the second place, it is exceedingly doubtful whether, in any pipe-line, the relationship between the actual and theoretical discharge may not vary to an extent greater than would be produced by the small differences in diameter in the proposed standards. In any case it is simply a matter for calculation for those who profess to work within such narrow limits.

**Strength and Testing of Cast Iron.**—The tensile strength has been fixed at the minimum of 9½ tons per sq. in., and the transverse strength, on the standard 2 in. x 1 in. bar with supports 36 in. apart, at the minimum of 28 cwt. and deflection of .33 in. The forms and dimensions of the test bars are illustrated in an appendix to the specification.

**Variations in Thickness, Length and Weight.**—The tolerances above and below the normal thickness, length and weight, have been fixed, but, after much consideration, it was decided not to introduce into a technical specification any clauses touching the question of the actual weight to be paid for by the purchaser, this being considered as a purely commercial matter, which would more properly be dealt with as a clause in the "General Conditions of Contract" or "Agreement."

It may, however, be observed that the system of payment at a price "per pipe or casting" is the simplest, and entails no calculation as to the deduction to be made for individual pipes or castings being heavier than the maxima weights specified, while all light-weight pipes would be rejected upon inspection.

**Casting Pipes.**—The enquiry showed that many current specifications provided for the heating of both the pipes before coating, and the composition itself, to unsuitable temperatures, such as would volatilize the lighter oils, and thus continuously change the consistency of the composition.

**Marking, Etc.**—Provision is made for using standard forms of identification markings, including the brand mark of the Engineering Standards Committee, and for weighing and registering the weights of all pipes and castings.

**Makers' Certificate.**—To meet cases where pipes or castings are bought from stock, or where the purchaser does not employ an inspector, provision is made for the issue, upon demand, of the Makers' Certificates, based upon the tests of the iron from which the batch of pipes was cast, and upon the hydraulic test applied to each pipe.

**Flanges and Machinery.**—The circular and bolt-hole dimensions of all flanges are to follow the existing Standard Flange Specification, which is in general use by engineers and valve-makers; while the thicknesses are arranged in two classes, AB and CD, and set out in Table 13 of the Specification.

Provision is made for the machining of all flange faces, and of the sockets and spigot-ends of turned-and-bored pipes. The taper on the latter has been fixed after careful enquiry, it having been found that if this is too steep the pipes rebound rather than make a good fit when driven up at the time of laying.

**Arbitration.**—Matters in dispute, arising out of the Specification, are to be the subject of arbitration, by a single arbitrator, to be agreed upon between the parties or, failing agreement, appointment by the Chairman of the Engineering Standards Committee for the time being.

**Tables.**—The Specification is accomplished by 14 Tables showing: (a) The dimensions and weights of each size and class of pipe; (b) The dimensions of each size and class of socket and spigot for pipes and specials; (c) the dimensions of standard flanges, and (d) The form and dimensions of ¼, ⅛, 1/16 and 1/32 bends, tees, 45° branches, enlarging and reducing tapers and collars.

In order to limit the number of Standard Tapers, differences in the diameters of the ends have, in general, been restricted to 2 in., and where greater differences have to be provided for, the tapers will have to be used in combinations of two or more castings.

## Sand Drag Train Stop

In connection with a description of the reconstruction of the Carmarthen bridge of the Great Western Ry., Mr. Henry Stuart Beville Whitley in Vol. CCIV of Minutes of Proceedings of Institution of Civil Engineers, gives the following information regarding the "sand drag" method of stopping trains:

To prevent an up-train after running past the stop signals from fouling the bridge when open, a sand-drag 270 yd. in length was laid in the up main-line west of the bridge connected with the running line by facing points. The sides of the trough consist of two angles, one 7 in. by 5 in., and the other 7 in. by 3½ in. with a standard bridge-rail laid in them, the whole being fastened to the main-line sleepers with galvanized coach-screws 6 in. long by ¾ in. in diameter. The reason for adopting this method of fixing was that the troughs could be laid without interfering with the main-line, while the unequal angles allowed a more equal clearance between the wheel-flanges and the sides of the trough. Sea-sand covers the rails to a depth of 3 in., and a distance of 1 ft. 2 in. is allowed between the running-face of the main-line rails and those in each trough.

Very exhaustive trials carried out for the purpose of testing the retarding action of various kinds of sand, and to ascertain the best section of trough to adopt, resulted in choosing the one described, and also proved that damp sea-sand was the most suitable material for use. For the purpose of these trials a sand-drag connected at both ends with the running-road was laid down on a level line, and the results obtained at the final trial are given in the accompanying tabulation, Table I.

It must be noted that no brakes were applied, and that, when the engine leading the train entered the drag, steam was shut off at the moment of entering.

Mr. Whitley believes that one of the earliest sand-bags to be used in Great Britain was laid down about 1860 on the West Cornwall Railway (now Great Western) near Hayle Station. For this drag two Darlow rails were fixed side by side and the space between them was filled to the head of the rails with sea-sand.

## The First English Fabricated Ship

The first of the national fabricated ships designed by a committee of British shipbuilders, was launched last August, by Swan, Hunter and Wigham Richardson, Ltd. The following description of the vessel is reprinted from Engineering of Aug. 23, 1918: The ship is 411 ft. 6 in. long, 55 ft. 5½ in. broad, 38 ft. 1½ in. deep, with a deadweight carrying capacity of 10,500 tons on a draught of 28 ft. 3 in. She is now being fitted with ordinary triple-expansion engines, and will have three boilers, each 15 ft. 6 in. by 11 ft. 6 in. She is the pattern vessel for 10 others which are to be constructed on the fabrication system with the aid of bridge-building works, and from her all moulds and templates have been supplied to the bridge builders for reproduction of the fabricated parts ready for erection in national and other yards. The object has been to utilize the available plant and labor of bridge-builders, which called for the simplification of both structure and form. As bridge-builders are unable to deal with curved surfaces a "straight-line" form was evolved, the curved forms of usual construction being eliminated as far as practicable. There is not a single bent frame in the ship, and all the plating, except some, of course, at the fore and after ends, is straight. Thus the bending of frames is rendered unnecessary, and the rolling of plates for "twist" and form is appreciably reduced. A good deal of additional work was involved in the design of the ship, but now that the first of the type is in the water, the duplicated parts will greatly facilitate the building of sister ships. The hull was constructed in 5 months, delay being caused by an epidemic of influenza and the incidence of the Tyneside annual holidays. The next ship will be built much more quickly. None of the material in this first ship is from the bridge-builders, but now they will come rapidly into production. The material can be accumulated as desired, and construction will proceed more speedily than ever before. The multiple punching machine was used to a greater extent on this vessel than hitherto, and was very successful, making good holes. All the spacing of the rivets was carefully worked out so that plans and wood templates could be made and sent to the bridge-building firms without delay for reproduction. The time and labor spent in perfecting this design is expected to yield handsome results. Minor improvements will come with experience, but the broad principle of the design has been worked out so successfully in the experimental ship that the pattern is likely to stand.

**Belfast Ship Building Records.**—The Belfast firm of Workman, Clark & Co. recently completed an 8,000-ton standard steel vessel and had it ready for trial in 3¾ days from the date of launching. Another firm completed a standard ship in 5 days from the date of launch.

TABLE I—TESTS TO DETERMINE RETARDING ACTION OF SAND DRAG

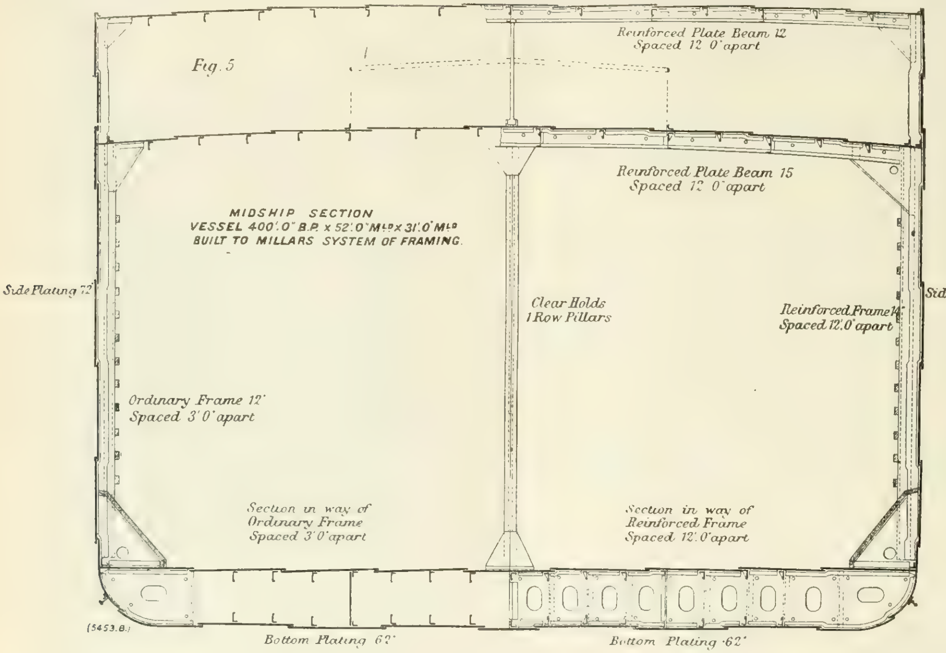
| Weight and composition of train. Composed of | Weight in [illegible] T. | Cwt. | Speed of train on [illegible] M.P.H. | [illegible] Ft. | [illegible] Ins. | [illegible] Composition | [illegible] Weight in [illegible] | Depth of sand [illegible] Before trial [illegible] | After trial Ins. |
|---|---|---|---|---|---|---|---|---|---|
| [illegible] ton brake van ........ | 20 | 4 | 24 | [illegible] | [illegible] | Van. | [illegible] | [illegible] | 1[illegible] |
| Engine of the 2-8-0 class [illegible] | [illegible] | | [illegible] | [illegible] drag | | [illegible] ton van [illegible] | [illegible] | 3 | [illegible] |

# The Millar System of Longitudinal and Transverse Ship Framing

From Engineering.

The Millar system of ship framing combines in the hull of a ship transverse framing and longitudinal decks and bottoms. The system has been applied already to six ships built or building by the Greenock and Grangemouth Dockyard Company, Ltd., at their works at Greenock and Grangemouth. The longitudinal system, as is well known, has been applied in many ships, and by many shipowners is preferred to the ordinary transverse system. But here the two systems are combined, with a view principally of giving the ship, as a girder, greater strength longitudinally against the stresses consequent on hogging and sagging, and great vertical stiffness against collision alongside wharves, piers, etc. Briefly, the double bottom of the ships, as well as the decks, are constructed with the main members running longitudinally, while the sides of the ship are constructed with vertical framing securely attached to the double bottom, either to the tank top or to the margin plate. The system so adopted by Mr. William Millar, the head of the dockyard company named, is a result of his experience in the repair of ships which had been subjected to strain in a seaway, and proof of advantage is afforded by the fact that the classification societies make a reduction in thickness of plates where longitudinals are fitted, because the strength is applied in the right direction. Not only is there increased strength, but a saving of at least 5 per cent. in steel, as compared with a ship having ordinary transverse framing. Moreover, the longitudinal bottoms give greater freedom inside the tanks between bottoms for cleaning, painting or repairing. The association of vertical frames with longitudinal members obviates breakage of stowage, the sparring in the side walls running straight through from end to end.

The longitudinals are placed parallel to the middle line, and are spaced 2 ft. 6 in. apart, extending from bilge to bilge. To ensure transverse strength in combination with longitudinal strength, and to support the bottom plating of the ship and the tank top, there are transverse floor plates about 6 ft. to 12 ft. apart, instead of from 26 in. to 30 in., as would be the case in a ship where the main framing of the bottom was transverse. The deck beams are similarly arranged longitudinally, with reinforced plate beams placed in a transverse direction at intervals of 12 ft. These are connected to strong reinforced vertical frames on the side of the ship, which are similarly connected at the bottom to the tank top or margin plate, as the case may be. The transverse deck beams are slotted, so that the fore and aft members are continuous, but they are connected to the deck plating as in the case of the longitudinals. These beams can be made so as to show clear holds without pillars, or they can be made to suit two rows of pillars.



Midship Section Showing Details of Construction for a Double Bottom, Side Framing and Deck Longitudinals.

# Training of Women for Work in English Munition Factories

From a paper, "'Some Notes and Observations Relative to Engineering in Great Britain During the War," published in the Proceedings Engineering Association of New South Wales.

The employment of women presented many difficulties owing to their lack of knowledge of machinery; but the Minister of Munitions early set in operation a scheme of training centers throughout the Kingdom, where the training is free, on the condition that the student undertook to enter a munition factory at the end of the course, which usually consisted of four hours a day, six days in the week, and lasted six weeks, or 144 hours in all. They were then qualified to enter the factories. The nature of the training is divided into bench work, at the vice, and operating machine tools, lathes, milling machines, etc. But students who show marked aptitude are selected for a further course of specialized instruction.

There are over 40 such training institutes, and the number of women trained has run into many thousands. Of course, women can also be taken direct into the factories and trained there, but the better results from the training centers has been so marked that it is a matter well worth continued observation, as the benefit to the industry that such training centers should be maintained as a permanency after the war for the purpose of training unskilled labor for the simple operations is unquestionable.

So far women have not taken the place of the highly skilled men to any great extent, but they have almost entirely replaced the unskilled and semi-skilled men in nearly all branches of mechanical engineering, not excepting shipbuilding. I saw many women working in a number of shipbuilding plants.

The employment of this unskilled or diluted labor has resulted in a great cheapening of production, and the manufacturer of munitions may be said to have come through three stages.

At first it was thought best to adopt existing machines, with special appliances and tools for the purpose in view, expecting to soon revert back to normal uses. This gave way to the second stage of constructing machines which, though suited for munition work, might be easily adapted for normal commercial work. This gave way to the third stage of building machine tools of the simplest description adapted for the one purpose of munition making, with the intention that they can be scrapped or discarded when the war is over, and arranged for one operation only. The making of shells is now generally carried out on that plan of one operation by one operator.

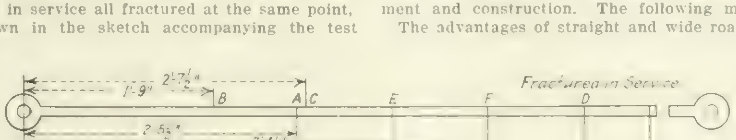
## Tests on Tie Bars from the 90 Year Old Menai Suspension Bridge

From the Engineer

The Menai suspension bridge, begun under Telford's direction in 1819, and completed in 1826, has now been over 90 years in service. With the exception of some damage caused by a windstorm in January, 1839, when one-third of the "hanger rods" are stated to have been broken, its history has been uneventful until recently. During the past two or three years, however, the suspender rods or tie bars have been giving considerable trouble, several having broken without apparent cause. The construction of these rods is peculiar, at least in the light of modern practice. Each of the members is made of several small pieces welded together, with an eye formed at each end. The bottom members of the rods are 6 ft. 6 in. long, and it is in these members that the trouble has occurred. As the factor of safety for the bars, allowing for the full traffic load on the bridge, but neglecting the windstresses, is eight, the cause of the failures was not at first understood.

In February, 1917, the Engineering Division of his Majesty's Office of Works sent one of the fractured bars to Messrs. David Kirkaldy and Son, for the ascertainment of its tensile strength. The test sheet received from Messrs. Kirkaldy is reproduced in Table I.

The results of these tests were considered quite satisfactory so far as the tensile strength was concerned. The bars which failed in service all fractured at the same point, namely, as shown in the sketch accompanying the test sheet, at a point a few inches from one of the ends. The fractures occurred always through solid metal, and not at a weld, and revealed a coarsely crystalline structure. The conclusion was reached, therefore, that the trouble was due to fatigue in the metal, and, therefore, that annealing would probably overcome it. Opinions on this point were sought from Mr. Basil Mott, C.V., M.Inst., C.E., Mr. Brearley of Sheffield, and the National Physical Laboratory. The report of the Laboratory was adopted, and it was decided to proceed forthwith with the remedial work. An annealing furnace is accordingly being laid down at one of the workshops near the bridge, and the bars are to be removed in small lots at a time and replaced after having been annealed.



Sketch of Tie Bar From Menai Suspension Bridge.

TABLE I. RESULTS OF TESTS TO ASCERTAIN THE TENSILE STRENGTH [illegible]

| Test No. | Description. | Dimensions. | Load Total lb. | Tons per sq. in. | Remarks. |
|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] in. or 0.1 per cent. |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | Permanent extension in 20 in. = .51 in. or 2.5 per cent. |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | Fractured tie bar—See sketch | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | Fractured tie bar—See sketch | [illegible] | [illegible] | [illegible] | [illegible] |

## Lessons of the War as Applied to Roads and Bridges

[illegible] Northern District Meeting of the [illegible] of Municipal Engineers

The author declared that never in the history of mankind had the enormous importance of solidly constructed roads and bridges been so evident as in this devastating war. In fact, so very often had highways, or the bridgehead "keys" to them, been the scenes of decisive battles, that the struggle might aptly be termed "The War of Roads and Bridges." Moreover, the possession of these vital lines of communication, of advances or of retreat, had certainly often proved the decisive factor of those battles.

Commander Maughan laid stress on the need for a reorganization of our roads on national lines, the classification of all roads and the "nationalization" of many. To do this efficiently, he urged, we might with advantage copy the good points in the French and other continental systems. It would, he said, be admitted by all who had had experience of the French system that our cross-channel allies always excelled in matters connected with personnel and the application of thrifty judgment in maintenance of roads, and he supported the formation of a "Business Road Government" in this country. Under it, he said, we should soon see an end of anomalies such as (1) undue and even wanton destruction of road surfaces and often of foundations, by traffic, by reason of the temporary impossibility—from the business point of view—of spreading the excessive weight over a sufficiently large area of roadway by such means as caterpillar tracks or the substitution of cushioning devices; (2) the exploitation of our national roads as free tracks or routes by private motor omnibus and road transport companies, or by "dividend hunters"; (3) the unequal incidence of rating. There was also, he added, need for a road "intelligence department," and for efficient census work. Commander Maughan then gave details of the lessons war had taught him as to road management and construction. The following may be cited:

The advantages of straight and wide roadways with wide shoulders; the importance of putting in sound foundation, and providing for efficient drainage of both road-bed and surface crust; the unassailable superiority of well-made and preferably bituminous-bound macadam roads for country roads, and even for the heaviest of traffic; the importance of leveled strips of turf adjoining the actual roadway and the absence of ditches and cross grips or side drains and the great advantage of piped-in side drains, especially on narrow roads and uniformity of standard of maintenance and of materials; the necessity of keeping trees well away from the roadway so that the branches overhung the footpath, but not the road; the delay, expense and danger of bottle-neck lengths, narrow bridges or odd lengths of road, dangerous corners and cross roads, railway crossings, etc.; the necessity for a constant and systematized study by road engineers of road traffic, and especially the effect of various classes of traffic under various weather conditions upon the various road-surfacingss and other materials used in the construction of roads with the co-operation of geologists and of chemists; the need for a similar study of traffic movements, of accidents and of enforceable safety precautions and road customs; last, but not least, the necessity for road engineers to combine to protect not only their own interests and those of road authorities generally, but also with representative bodies of road users for the benefit of the country at large.

As regards highway bridges, the author thought that, generally speaking, we had little to learn from our Allies. So far as "over" bridges were concerned, it was safe to say that supporting piers in the middle of the roadway would not be tolerated in this country any more than would the innumerable level crossings which mar the general excellence of the roads of France.

# Paints and Prevention of Corrosion of Iron Work

In a paper presented before the Iron and Steel Institute Prof. J. Newton Friend described his investigation for determining the broad general principles for the successful application of paint to iron for the prevention of atmospheric corrosion. Plates coated with various paint mixtures were exposed to the weather for periods varying from 5 months to 2½ years. The loss in weight due to corrosion was thus ascertained. His summary of the results of his tests follows:

The practical value of acceleration tests is very small in the present state of our knowledge. Reliable results can only be obtained from tests carried out under conditions closely resembling those prevailing in practice.

Addition of pigment paint to oil increases the efficiency of the latter as a protective paint until a maximum is reached. After this, further addition of pigment causes deterioration. The best results are obtainable from paints possessing as high a percentage of good oil as is compatible with good body and any other working property that has to be considered.

Linseed oil on setting expands by some 3.3 per cent. This is the primary cause of crinkling. Further oxidation causes a decrease in volume, which in time leads to cracking.

Linoxyn is permeable to moisture. The permeability is reduced by heating in absence of air, the oil increasing in density, viscosity, and molecular weight.

Polymerized linseed oil affords a better protection than raw oil when used as a paint vehicle.

The functions of a pigment are to toughen the film and render it less permeable to water-vapour and oxygen. It also reduces the expansion of the oil on setting, and thus minimizes the tendency to crinkle.

A thick coat of paint protects the underlying metal more efficiently than a thin coat, provided the coat is not so thick that running or crinkling takes place.

The very best results are obtained by multiple coats. Two thin coats are better than one thick one of equal weight.

Thinners enable thin coats of paint to be applied. Turpentine leaves a very slight residue behind upon evaporation, but its effect on the efficiency of the paint is small.

Other things being equal, the most permanent paints are those containing black or red pigments, since these absorb the shorter rays of light, and prevent them from hastening the destructive oxidation of the linoxyn by the air.

Finer pigments afford more efficient protection than coarse pigments, since they are more thoroughly in contact with the oil.

Iron structures should be painted whilst their scale is still on, after loosely adherent flakes and rust have been scraped off. The paint will last rather longer than if applied to the pickled or sand-blasted surface, and the labor of removing the scale is saved.

Experiments with rusty plates are not conclusive, but suggest that the rust need not be so carefully removed, prior to painting, as is usually thought to be necessary.

# The West Quay of Madras Harbor

From a paper presented before Institution of Civil Engineers.

The object of the paper is to describe how at a cost of 200,000l. 3,000 lin. ft. of a quay, fit for vessels of Suez Canal drafts, has been constructed along the west, or shore, side of Madras artificial harbor. The quay in question has replaced the shelving, sandy shore, and, by allowing dredging to be done, has enabled the port authority to enlarge the area of the enclosed harbor, available for shipping, from about 100 acres to about 200 acres.

The quay is constructed mainly of granite cement, concrete faced with granite masonry. It rests on about 70 double-aperture wells or monoliths, sunk to a depth of 55 ft. below low water, or to a depth of 23 ft. below the dredged bottom of the deepest berths. Of the wells 21 are 50 ft. by 28 ft., 3 are 44 ft. by 28 ft., 21 are 43 ft. by 24 ft., and 19 are 35 ft. by 20 ft. Besides 64 deeply-sunk, or regular, wells, there are at each end a few smaller and shallower wells, where the quay crosses the rubble base of the old harbor breakwaters. Throughout the full length, 2,980 ft., of the quay, its breadth, on top of the wells, is 24 ft. Its height above Indian spring low water is 12 ft. The wells are shod at the bottom with steel curbs weighing in the aggregate about 1,000 tons, made by local firms.

The strata through which the wells were sunk is sand or clayey sand, real clay not being met with until a depth of 77 ft., and rock not until a depth of 113 ft., is reached. All the wells leaned forward 4 in. to 8 in. as the sea-bed was dredged from the fronts of them and the earth-pressure came on at the back. This forward movement, once it was fully recognized and diagnosed, was compensated for by leaning the wells backward with a batter in the sinking, so that by the time the superstructure came to be built the top face of the line of wells was about 6 in. back from its ultimate position. The all-over cost of the finished quay—in spite of war prices for a part of the cement used—ran to practically Rs. 1,000, or 66⅓l. per lin. ft.

The quay is equipped with five groups of 1-ton hydraulic cranes for working cargo in and out of lighters at the places which ordinarily will be free of steamers. Overhead, or portal, 35-cwt. hydraulic cranes for plumbing ship's hatches are under order, but are delayed because of the war. The quay affords berthing for four steamers of the average Suez Canal class; or, in an emergency, when some of the groups of small, or barge, cranes will be masked, for six smaller vessels. Trains of both the South Indian gages (5 ft. 6 in. and 1 m.) have access to the full length of the quay, which is equipped throughout with transit sheds 120 ft. wide, placed 112 ft. back from the quay face. The quay has already been used extensively, even when only half finished. Pending the instalment of cranes, its working capacity has varied, ship's own derricks only being used, from 1,200 tons in a day for coal down to 500 tons in a day for rails per steamer.

*Road and Street Monthly Issue*

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**Roads and Streets—1st Wednesday**
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies

**Waterworks and Hydraulics—2nd Wednesday**
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power

**Railways and Govt. Works—3rd Wednesday**
(a) Excavation and Dredging
(b) Rivers and Canals
(c) Harbors and Docks
(d) Railway Construction

**Buildings and Structures—4th Wednesday**
(a) Buildings
(b) Bridges
(c) Ship Construction
(d) Miscellaneous Structures

Volume L. CHICAGO, ILL., NOVEMBER 6, 1918. Number 19.

# "I Haven't the Least Doubt That Street Dust Disseminated the Influenza"

The great epidemic of influenza has already killed almost as many American soldiers in America as German bullets have killed in France since we entered the war. In the cantonments alone more than 300,000 cases of influenza have occurred, of which 16 per cent developed pneumonia, and more than 16,000 have died. Our total casualties in France have been but slightly more than 50,000, of which about 20,000 have been deaths. Yet we have had soldiers in France for 18 months, whereas influenza has been epidemic in America less than one-sixth as long as that.

Our two million soldiers in France have been facing a much less deadly enemy than the two million in our training camps at home. The greatest number of our casualties reported in a single day from France was 1,200. The influenza casualties in our cantonments have averaged four times that number for sixty days. Consider what our consternation would have been had as many of our boys in khaki been struck by lead as were struck by microbes during the past two months.

The pity of it is that the casualties from influenza microbes were avoidable, for the most part. We have simply repeated the history of the Spanish war when our soldiers died like flies, and largely because of flies. Then it was typhoid, and the germs were carried from camp privies by flies to the food that the soldiers ate. The cause of typhoid and the methods of its dissemination were almost as well known to physicians then as now. Yet a disgraceful lack of precaution led to thousands of deaths among our soldiers in Florida and other southern states.

When the sanitary history of this present war comes to be written, we believe that it will be said that most of the deaths from pneumonia and influenza could have been prevented, even as it was said after the Spanish war that the loss of life from typhoid was largely preventable. Almost from the start of this present war, pneumonia began to claim victims in our army camps, not by ones and twos, but by scores. And the death roll had grown steadily and alarmingly larger even before the epidemic of influenza began. Since then the loss of life has been astounding.

The public has been told that the army camps are more healthful than the homes from which the men came, and attention has been called to the low annual death rate per thousand men in camp. But such statistics are misleading, for the normal death rate of men between the ages of 21 and 31 is only a small fraction of that of the entire population, including infants and aged. Bear in mind also that medical examiners weeded out all who were not in the prime of physical condition, and you will realize how deceptive is any comparison of death rates in our army camps with death rates in our cities.

Doubtless many a civilian has concluded that a high death rate from pneumonia is unavoidable where men are exposed to all sorts of weather, but that is not so. The writer, as a civil engineer and contractor, has lived out in camps a considerable part of his life; and his experience has taught him that men exposed merely to bad weather seldom have pneumonia. Pneumonia is a germ disease that is transmitted mainly in the dust. The germs are expectorated and are then blown about with the dust. The cause being known, the preventions are obvious. First, the sputum of all persons having "colds" should be prevented from reaching the floors, walks, roads and streets. Second, every effort should be made either to remove the dust frequntly or to lay the dust by sprinkling with oil or water—preferably oil. Third, the throat and nose should be washed and sprayed immediately after every exposure to dust that may contain germs. In a recent address to the street cleaning contractors of Philadlphia, Dr. William Pepper, of the University of Pennsylvania, said:

> [illegible] oftener it is done, the better conditions will become. Personally, [illegible] the collection of garbage, for while I cannot see any great disease [illegible] very distinct menace in the dust that now blows around our streets with every wind. I haven't the least doubt that dust was the original disseminator of epidemic influenza in the camps [illegible] dust carrying the contagious bacteria.

Dr. Pepper merely states what has been known for years In Engineering and Contracting we have published dozens of editorials urging the flushing of streets to remove microbes. City streets should be kept almost as clean as a hospital floor; and it can be done, as has been shown in several cities, at a very moderate cost, provided the streets are well paved.

What is true of city streets in this respect is obviously true of the streets in our army cantonments and of the drill grounds. Yet what do we see there? For the most part we find cheap, dusty pavements (where there are pavements) and drill grounds that are so dusty as to be ideal places for the dissemination of bacteria that attack the respiratory passages and organs. Instead there should be what? Concrete, asphalt, brick or other smooth, hard pavement over every yard of every cantonment street and sidewalk. These pavements should be washed clean every night, if not oftener. The drill and parade grounds should either be paved in a similar manner and similarly kept clean; or, if a yielding surface is desired, they should be covered with sand bound with an asphaltic oil. When asphaltic oil of the right consistency and in abundance is used, and when maintenance is adequate, practically no dust rises from such an oiled surface. Every soldier should be taught to use his handkerchief every time that he clears his nose or throat. He should be made to realize that the handkerchief is the gas mask idea reversed, its object being to prevent germs from going forth on their mission of illness or death to other men.

Civil engineers have done vastly more than doctors toward preventing typhoid fever, because it has been the construction of sewers and the filtering and chlorinating of water to which the disappearance of typhoid is mainly attributable. In like manner we look to see civil engineers become the main factors in causing the disappearance of the respiratory diseases, for they will lead the public to appreciate the health value of good pavements kept clean.

## Unwise Curtailment of Truck Manufacture and Highway Construction

Now that the war is so near its close perhaps it is useless to complain further about the various acts of the federal government that have led to such great curtailment of road and street work. However, there is food for reflection in the fact that after the many years of publicity as to the necessity of good highways, there should still be in public office men who class highways among the non-essentials—the gum and gewgaw factories and the countless list of plants that produce nothing that adds to economic welfare.

When the highway commissioner of a great state is compelled, by a sense of public duty, to arraign the National Highways Council, surely it is time for engineering societies to investigate. J. Denny O'Neil recently said:

> The Highway Department of Pennsylvania is of the opinion that the National Highways Council has failed to realize the importance of road work in Pennsylvania and the great hardship that will be imposed upon the local communities by leaving the roads in an unfinished condition.

He pointed out that unless the National Highways Council recedes from its present position, road construction in Pennsylvania will practically cease until after the war.

Doubtless our readers were equally amazed when they read in the daily papers that the War Industries Board had limited next year's manufacture of motor trucks to 25 per cent of last year's output. Thus between these two national boards not only is road improvement brought to a standstill, but an end is put to the making of new rolling stock for highway haulage.

We are told, of course, that we should voice no protest and be patriotic. But must we be idiotic in order to qualify as patriots? The Labor Board tells us the country needs a million more workmen. The War Board is preparing to double or triple that shortage by drafting another million or two. Then along come two other boards and virtually tell us that highway transportation is not a necessity. At the same time a fifth board is robbing every other industry of steel in order to build ships four times faster than they are being sunk. In spite of unceasing protests against the conduct of the war without a co-ordinating central head, a year and a half of war finds us still headless in that respect. No one has yet seemed to see that distinctions between "economic necessity," "war necessity," and "bare necessity." In fact no definition of any sort of "necessity" has been framed by government boards. Hence we have candy shops that have been allowed three-fourths their normal quota of sugar, and motor truck factories allowed but one-quarter their quota of steel. Building material makers have been forced to reduce their output by half, but fancy button makers are permitted to go along on a 75 per cent basis. Dry goods stores report almost no dimiuntion in sales, but the sellers of brick have almost shut up shop. In short, the producers of durable and useful wealth—buildings, highways, etc.—have been asked to quit almost completely; while the producers of useless wealth that melts in the mouth or bedecks the back, have been allowed to produce with little let or hindrance.

More than half a century ago Herbert Spencer, the English philosopher, wrote: "Men deck their minds as they do their bodies, in the prevailing fashion." Evidently there has been little change since that was written. The minds of most men, even among those called educated, are still decked with frivolities; and the science of economics remains to them as vague as the inscriptions on the tomb of a Ptolemy.

## Herbert Hoover Tells How to Reduce the Cost of Farm Produce by Motor Trucking

The retail prices paid by the consumer of farm products usually average double the prices received by the farmer. This is true even where the haul is relatively short. One of the causes of this uneconomic condition is the high cost of haulage over poor roads. Perhaps even more serious is the spoilage of perishable foods. At a recent conference of the Highways Transport Committee of the Council of National Defense, Herbert Hoover said that half our perishable foodstuffs are wasted, largely through lack of efficient transportation. He regards fast motor-truck express service as being one solution of the problem of securing fresh, low-priced farm products. Moreover, the use of tractors for farm plowing, tilling, etc., coupled with the use of motor trucks for hauling from the farm to market or to railway stations, will eliminate most of the draft horses. These animals eat the crops of millions of fertile acres, and they eat every day of the year, although they do not average three working hours daily. Hence the elimination of horses will reduce the cost of food by adding greatly to the acreage of soil used to produce food for men.

We may add that if motor truck express charges are to be reduced to a minimum, it will be necessary not only to build good highways, both in country and city, but to restrict trucking competition. It may come about that Uncle Sam himself will control express trucking even as he now controls the railways and the railway express companies. Certainly it will be an economic blunder to permit unrestricted competition among motor truck expresses. We have only to look at the high cost of delivering milk over city streets to see what comes of duplication and reduplication of milk wagons traveling the very same routes.

## Nearly Half a Million for Horse Races But Nothing for City Pavements

During all last summer horse race meets were held in all the states that permit gambling. At one city of 20,000 people there were daily races for a period of two weeks, and the money taken in by the promoters totaled $400,000, or $20 per capita. A small percentage of this money was paid to the city for expenditure on its parks. Like most small cities, its streets are poorly paved—most of them being unpaved. Yet if some public spirited committee had attempted to raise $400,000 by popular subscription for street improvements, does any one imagine that even one-tenth that sum could have been secured? That $400,000 would have laid a pavement 18 ft. wide down the center of 20 miles of streets, which would have been not only something of which to speak with pride, but a cause of greater comfort, health and economy to all the residents.

At the very time that these people were "blowing in" nearly half a million dollars on horse races, the federal government was preventing the city from doing needed street paving. This is indeed a great nation, and its folly is often as great as its other greatnesses.

## Engineering Societies Should Secure Appropriations for Public Works Upon Which Men May Be Employed After the War

An engineer officer writes from France urging his brother engineers at home to do their bit toward providing useful work for him and his companions as soon as the war ends. He points out that it takes few engineers to make surveys for construction purposes, that extensive surveys are not to be made in a moment, but that extensive surveys must be made before extensive public works can be begun. What are the engineering societies doing to secure quick action in this respect. Local engineering societies should have representatives go before city councils to show the necessity of promptly beginning surveys, plans, etc., for extensive street, sewer and water works improvements. Articles should be written by engineers for the local newspapers, pointing out both the economic need of such improvements and the patriotic incentive that should actuate the public now in providing useful work for the soldiers who will soon return.

Similarly the national engineering societies should take steps immediately to arouse Congress and the state legislatures. Unless intelligent and aggressive leadership is now taken in a campaign for intensive public works, we shall soon find ourselves surrounded by thousands of idle men eager to work but with no work ready for them to do.

There is nothing novel in suggesting that the returning soldiers should be provided with work of a public nature. It is generally conceded that this will be both the economic and the patriotic thing to do. The trouble is that every one is waiting for George to do it. Well, George is as good a name as any for us members of engineering societies. Let us all be Georges, and go to it—now.

## Snow Removal from Connecticut Highways

About $40,350 was expended by the State Highway Department of Connecticut for removal of snow from trunk highways in 1917. The mileage covered was 970, and, including the cost of equipment, the rate per mile was about $45. Under normal conditions of snowfall, this cost would probably have been less than $30 per mile. For its work last winter the Department planned to use 18 snow plows attached to the front of its trucks. These proved inadequate because of the unusual winter conditions, and were supplemented by tractors and road machines. On heavily traveled routes practically all the snow was removed while on mixed traffic roads about 3 in. were left. For the coming winter 20 more snow plows for use on the front of trucks have been added to the equipment. As the result of experiments made in 1917, the Department found that the removal of snow decreased the cost of bituminous repairs the following spring by at least one-third. This is accounted for by the fact that when the snow is not removed the truck traffic is confined to one or two sets of ruts, which ultimately are worn into the road surface.

**Bill Before Congress for National System of Highways.**—A bill was introduced in the Senate on Oct. 17 providing for the "taking over, improvement, relocation, construction and maintenance of a system of national highways and state highways, designed to facilitate the movement of troops, equipment, munitions and supplies, and to promote the general welfare of the people of the United States." The bill carries an appropriation of $100,000,000 for defraying the expenses of taking over, improving, constructing and maintaining the highway systems.

## Standardization of Consistency for Asphalt

In a paper presented at the last annual convention of the American Society of Municipal Improvements Mr. J. R. Draney, General Sales Manager, U. S. Asphalt Refining Co., calls attention to the many varieties of penetration required in the production of asphalt for paving purposes and points out that standardization of consistency for the material is much needed. He stated that, under similar conditions, one city will prefer a penetration of from 60 to 65, while another city will require a penetration of from 55 to 60 or 65 to 70, and there are some cases where a penetration of from 70 to 75 has been required for sheet asphalt. Penetrations of from 35 to 40, 40 to 45, and 45 to 50 are also required.

There is also a variation in penetration requirements for asphalt to be used in asphaltic concrete, but these variations do not cover as wide a range as the asphalt required for sheet asphalt work. Penetration requirements for asphaltic concrete range from 60 to 65, 65 to 70, 70 to 75, and 75 to 80, and in some cases between 80 and 90, but the latter is demanded only where asphaltic concrete carrying a goodly proportion of large-sized stone is used.

Asphalt to be used in asphaltic macadam by the penetration or pouring process, is likewise called for by the trade in penetrations ranging from 90 to 190, and there are many instances where penetration of from 80 to 100 is demanded. Probably the penetration that is more largely required averages from 110 to 120. The specifications of the New York State Highway Department require from 140 to 190.

The company with which Mr. Draney is connected has manufactured asphalt in the last few years with penetrations covering a total aggregate of twenty different ranges for sheet asphalt, asphaltic concrete and asphaltic macadam. Quite often the refinery may have on hand a stock of asphalt with several ranges of penetration, but will be out of the penetration required for that "hurry up" order which must be shipped immediately. According to Mr. Draney, there are but three varieties of penetration necessary for sheet asphalt, one for streets with heavy traffic, one for moderate traffic and one for light traffic. The same may be said of asphalt required for asphaltic concrete pavements. For asphaltic macadam there should be one range of penetration and that a fairly wide one. For example, a specification giving a penetration requirement of from 100 to 125 would cover the matter properly and effectively.

## Rental Rates for Road Equipment

The following tabulation, showing rental paid for use of equipment in state highway work done in 1917, under the new form of contract employed by some highway departments, is taken from a bulletin, "Highway Cost Keeping," issued recently by the U. S. Office of Public Roads and Rural Engineering:

| | |
|---|---|
| Air compressor drill outfit while necessarily on site of work, per day | $[illegible] |
| Crusher, including screens and bins, per day | 8.00 |
| Concrete mixer and labor, per cu. yd. concrete | [illegible] to 1.72 |
| Grader while necessarily on site of work, per day | [illegible] |
| Steam roller, per lin. ft. of roadway rolled | .06 |
| Steam shovel while necessarily on site of work, per day | 20.00 |

Small tools, such as lanterns, rubber boots, axes, hammers, drills, bars, plows, harrows, picks, shovels, wheelbarrows, and the like character, were included in the unit prices paid for completed work. The work was done by a contractor who was paid a fixed amount for units of work completed. All materials used were paid for by the state. The contractor furnished coal, oil, repairs, etc., for his equipment at the rentals quoted above.

The following table shows the rental paid for use of equipment on state highway work in 1917, the work was done by state forces, the equipment being owned by towns and individuals:

| | |
|---|---|
| [illegible], per day | $[illegible] |
| [illegible] bins and [illegible], per day | [illegible] |
| [illegible], per day | [illegible] |
| [illegible], per day | [illegible] |
| [illegible], per day | .50 |
| Trucks, [illegible] capacity, driver, fuel, repairs and all supplies necessary, per day | 18.00 |

[illegible] and repairs furnished by state.

# The Measure of a Good Road

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The term **good road** is, at the present time, used in a rather loose way and really conveys little or no definite meaning, because good is only a relative term and requires some standard of excellence with which to make a comparison. If such a standard of excellence could be specifically defined and a method devised for comparing the **goodness** or **badness** of various roads with this standard, a precise meaning could be given to the expression **good road**, and it would then become possible to tell to what extent any particular road is good. This standard of excellence should be such that no actual road could surpass it. For a road connecting two fixed termini, such a standard, considered from the operating standpoint, is fixed by the following geometrical and physical limitations:

1. A straight line is the shortest distance between two points.
2. A plane of uniform slope is the best grade between two elevations.
3. A hard, smooth surface offers less tractive resistance than a rough or yielding surface.

In other words, the standard road is the one that requires the expenditure of the least energy per unit load in getting over it. Any other road between the two selected termini would involve the expenditure of more energy in traveling over it. This needed excess of energy divided by the energy required for the standard road is the measure of the **goodness** or **badness** of the road in question. The smaller this ratio the better the road. For a definite measure, this ratio must be expressed in terms of the characteristics of the road. This may be done as follows:

Let

$S_0$ = Straight line distance between termini.
$S_1$ = Actual distance by the road.
$E_0$ = Elevation of the lower terminus.
$E_1$ = Elevation of the upper terminus.
$E_s$ = Elevation of any intervening summit.
$E_v$ = Elevation of any intervening valley.
$T_0$ = Tractive resistance of ideal pavement.
$T_1$ = Tractive resistance of actual pavement.

The work done per ton of load in overcoming the tractive resistance of the actual road is $S_1 T_1$. The work done in lifting the unit load through the successive heights is $2000 (E_{s_1} - E_0 + E_{s_2} - E_{v_1} + E_1 - E_{v_2})$*. The sum of these two quantities is the total work done per ton of load on the actual road. If this sum be represented by $W_1$, the result is

$$W_1 = S_1 T_1 + 2000 (E_1 - E_0 + \Sigma E_s - \Sigma E_v)$$

For the ideal road, let $W_0$ represent the total work to be done, then we have

$$W_0 = S_0 T_0 + 2000 (E_1 - E_0)$$

The required excess of energy $= W_1 - W_0$.

Then $\dfrac{W_1 - W_0}{W_0}$ is the measure of the **goodness** of the road in question, or, in other words, this ratio becomes the characteristic coefficient. By substituting the above equivalents in this ratio, we have

$$\frac{W_1 - W_0}{W_0} = \frac{S_1T_1 + 2000(E_1 - E_0 + \Sigma E_s - \Sigma E_v) - 2000(E_1 - E_0) - S_0T_0}{S_0 T_0 + 2000 (E_1 - E_0)}$$

$$\frac{S_1T_1 - S_0T_0 + 2000(\Sigma E_s - \Sigma E_v)}{S_0 T_0 + 2000 (E_1 - E_0)} = \Big\} \text{the characteristic coefficient.}$$

It is necessary to distinguish between this **ideal road**, which is proposed as a basis for comparison, and the **economic road** that should actually obtain in practice. It is readily seen that with certain topographical conditions, the expense of building an air line road with a uniform gradient between two given termini might easily become so great as to be prohibitive—or in other words, it would be better economy to pay more for wasted energy than to pay interest on an excessively large investment for grading. There is a relation between the interest charge and the annual cost of energy such that as one decreases the other increases, though not necessarily in the same proportion. If this relation between these two factors can be expressed in definite terms, it is possible to determine the range of economy and the point at which the greatest economy occurs. Although our present data are incomplete, yet an approximate relation can now be formulated and a tentative conclusion reached.

For the present discussion it is sufficiently accurate to say that the annual cost is the sum of the interest charge and the annual cost of the energy required to operate over the road. This energy is expended in two ways; viz, overcoming tractive resistance and lifting the load through vertical distances. The interest charge arises from the investment that is required to reduce tractive resistance and the height of lift. Let:

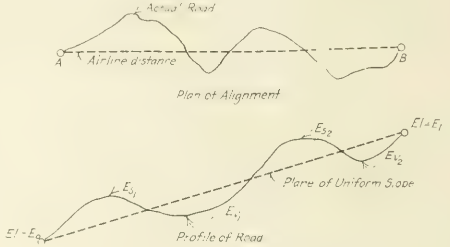

Fig. 1.

$C_a$ = total annual cost.
$I_r$ = interest charge for reducing resistance.
$E_r$ = cost of energy to overcome residual resistance.
$I_L$ = interest charge for reducing height of lift.
$E_L$ = cost of energy to overcome residual lift. Then
$C_a = I_r + E_r + I_L + E_L$.

The next step is to express these factors in terms of a common variable. This can be done from the following considerations:

Tractive resistance can be decreased by putting in pavement of increasing degrees of hardness, smoothness, and durability. The cost of this pavement varies roughly as its hardness and resistance to wear. Then the cost also varies inversely as some function of the tractive resistance T (see Fig. 2), and the interest charge varies directly as cost, therefore

$$I_r = \frac{a}{T^n} \text{ where a is constant.}$$

The energy required to operate varies directly as the residual tractive resistance, or

$$E_r = b\,T, \text{ where b is a constant.}$$

The cost of the "lift reduction" varies directly as the amount of grading required. If h measures the amount of lift reduction and L the residual lift, then $L + h = L_0 =$ the original lift which is a constant for any particular case. Also $h = L_0 - L$.

The cost of grading is closely represented by the expression, $Ah^2 + Bh^3$ where A and B are constants. This may be expressed in terms of the residual lift. Thus

Cost of lift reduction $= A (L_0 - L)^2 + B(L_0 - L)^3$

Interest charge $I_L = c[A(L_0 - L)^2 + B(L_0 - L)^3]$

The energy required to overcome the residual lift L varies directly as L, therefore the annual cost

$$E_L = eL, \text{ where e is a constant.}$$

The expression for total annual cost now becomes

$$C_a = \frac{a}{T^n} + b\,T + c\,[A (L_0 - L)^2 + B(L_0 - L)^3] + eL$$

The desideratum is so to adjust these factors that $C_a$ may become a minimum. The usual process of placing the first derivative equal to zero may be followed. As there is no relation between tractive resistance and residual lift,

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*The form of this expression varies, depending upon the order of sequence of $E_{s1}$ and $E_{v1}$ and the relation of $E_0$ and $E_1$ to series. There are four cases, as follows:

1. $E_{v1}$ precedes $E_{s1}$ and is lower than $E_0$, while $E_1$ is lower than the final summit. Then
   Lift $= \Sigma E_s - \Sigma E_v$.
2. $E_{v1}$ precedes $E_{s1}$ and is lower than $E_0$, while $E_1$ is higher than the final sag. Then
   Lift $= \Sigma E_s - \Sigma E_{v1} + E_1$
3. $E_{s1}$ precedes $E_{v1}$ and is higher than $E_0$, while $E_1$ is lower than the final summit. Then
   Lift $= \Sigma E_s - \Sigma E_v - E_0$
4. $E_{s1}$ precedes $E_{v1}$ and is higher than $E_0$, while $E_1$ is higher than the final sag. Then
   Lift $= \Sigma E_s - \Sigma E_v + E_1 - E_0$.

T is independent of L. Therefore it will be necessary to differentiate separately with respect to T and L.

Selecting T first

$$[illegible]$$

Now the relation between interest charge and cost of energy for traction is represented by the ratio $\frac{I_r}{E_r}$

For the minimum annual cost, this expression becomes

$$\frac{I_r}{E_r} = \frac{aT^{-n}}{bT} = \frac{a}{bT^{\text{[illegible]}}} = \frac{a}{b\frac{na}{b}} = \frac{1}{n}$$

From Fig. 2, it is seen that, in the light of our present information, n may be taken as unity, therefore $I_r = E_r$.

In this instance the criterion reduces to a very simple statement as follows:

**The maximum economy for any particular type of pavement obtains when the annual cost of energy equals the interest charge for the pavement.**

Next considering L as the independent variable, we have

$$\frac{dC}{dL} = 2eA(L_o - L) - 3eB(L_o - L)^2 = 0$$

$$\text{or } 2A(L_o - L) = 3B(L_o - L)^2$$

$$\text{or } \frac{2A}{3B} = L_o - L \text{ and } L = L_o - \frac{2A}{3B}$$

The relation between interest charge and cost of energy for lift is represented by the ratio $\frac{I_l}{E_l}$

For a minimum annual cost this becomes

$$\frac{I_l}{E_l} = \frac{A(L_o - L)^2 - B(L_o - L)^3}{eL}$$

$$= e\left[\frac{A\left\{L_o - \left(L_o - \frac{2}{3}\frac{A}{B}\right)\right\}^2 - B\left\{L_o - \left(L_o - \frac{2}{3}\frac{A}{B}\right)\right\}^3}{L_o - \frac{2}{3}\frac{A}{B}}\right]$$

$$= e\left\{\frac{\frac{4A^3}{27B^2}}{L_o - \frac{2}{3}\frac{A}{B}}\right\}$$

This is the relation sought. It is not expressible in a simple statement and only acquires its fullest significance for a particular case for which the constants have been determined.

Reverting to the criterion that has just been established for the economic type of pavement, we shall see that this principle furnishes a basis for determining approximately the kind of pavement that will be most economical for a given density of traffic. If a pavement 9 ft. wide be selected as a unit, then a mile length will contain 5,280 square yards.

Let p = cost per square yard of pavement.

Then 5,280 p = cost per mile.

And 264 p = interest charge at 5 per cent.

Again let T = tractive resistance per ton of load.

Then 5,280 T = work done per ton of load.

Assuming that the engine can develop a horsepower-hour on a consumption of 1.2 pints of gasoline, the gasoline required $= \frac{5280\ T}{1,980,000} \times 1.2 = .0032\ T$ pints. Cost of gasoline at 3 ct. per pint = .03 × .0032T = .000096 T dollars per ton of load. If L = annual load in tons, then annual cost of energy = .000096TL. According to the foregoing criterion for maximum economy, we have

$$264p = .000096\ T\ L.$$

For any particular type of pavement p and T would be known so that L may be computed. Solving the equation for L we have

$$L = \frac{264p}{.000096\ T} = 2,750,000\frac{p}{T} \text{ tons per annum}$$

The economic density per diem would be

$$L' = \frac{2,750,000}{365}\frac{p}{T} = 7534.2\frac{p}{T} \text{ tons}$$

This relation is set forth graphically in Fig. 3. If there were a rigid relation between the price of pavement and its tractive resistance, it would be helpful to replace p with its tentative equivalent, $\frac{70}{T}$, and the equation would then become

$$L' = 7534.2 \times \frac{70}{T}$$

A single curve showing the economic tractive resistance for any given density of traffic would thereby result. However, owing to the lack of such rigid relation, it did not seem desirable to plot such a curve. Prices will fluctuate from time to time and vary with different localities and, therefore, will conform only approximately with the curve set forth in Fig. 2.

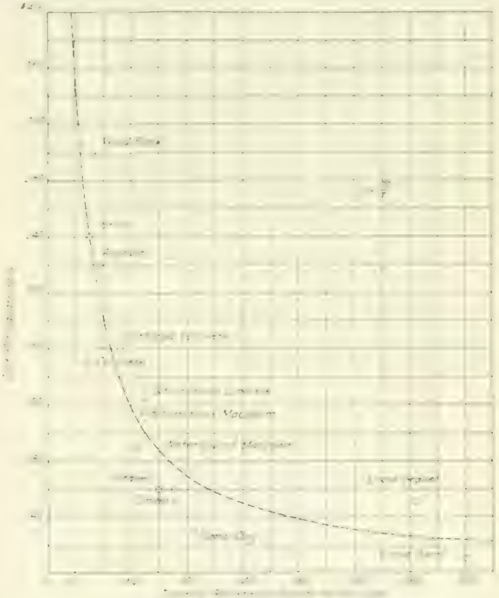


Fig. 2.

In order to make clearer the application of the foregoing principles, an example taken from actual practice will be given. For this purpose a short stretch of the road which it is planned to make over for a part of the state highway connecting St. Louis and Kansas City will be selected, as the needed information is largely at hand. This stretch of road extends westward from Jefferson City to the Country Club and is locally known as the South Branch of the Ten-Mile Drive. At present it carries considerable traffic, largely the passenger type. After improvement and connecting up with the various other links of the state highway, it will carry more traffic and a larger percentage of it will be motor trucks hauling freight. The characteristics of the road are given in the following table:

[illegible]

Other changes in alignment = 11 bends, total deflection = 41° +.
Longest tangent = 735 ft.
Steepest grade = 7 per cent, length 200 ft.
Difference of elevation between termini = 210 ft.
Total height of lift = 337 ft.
Excess lift = 127 ft., = 60.5 per cent.
Estimate of average daily traffic based upon counts made by writer = 200 tons.
Gravel pavement (worn) tractive resistance = 110 lb.
Gasoline consumed per ton of load = 3 pints.

Applying the formula for characteristic coefficient, we find that the goodness of this piece of roadway thusly measured is

$$\text{c.c} = \frac{22{,}522 \times 110 - 19{,}600 \times 6 + 2{,}000 \times 127}{19{,}600 \times 6 + 2{,}000 \times 210}$$

$$= \frac{2{,}105{,}820}{537{,}600} = 3.92 \text{ nearly.}$$

In other words, the excess or waste energy is 392 per cent of that required for traveling over the standard or ideal road. In this determination no account has been taken of the possibility of utilizing the momentum acquired on a descending grade to carry the car up the next ascending grade, because the momentum of highway vehicles is destroyed to a large extent by the roughness of the pavement and by the slacking up in approaching other vehicles or intersecting highways. This loss of momentum is readily apparent on a gravel pavement, because the tractive resistance is about on a par with that of a 4 per cent gradient, and because the unevenness of the surface, after the pavement has been used awhile, becomes quite a factor in reducing momentum. On account of this loss of momentum, it becomes necessary to use additional energy to surmount the successive summits. It is this process of going up hill to get down again, of lifting the load over a series of intervening summits that calls for additional gasoline. If this excess lift of 127 ft. could be reduced to zero by a change in alignment or a grading off of summits, there would result for this particular case an annual saving of $337 as may be seen from the following simple computation:

Work done per ton of load under present conditions = 2000 × 127 = 254000 ft. lb.

Assuming as before that 1.2 pints of gasoline are required per horsepower-hour, we have—

$$\text{Gasoline required per ton of load} = \frac{254000}{1{,}980{,}000} \times 1.2 = .154$$

pints for an average daily traffic of 200 tons.

Consumption of gasoline = 200 × .154 = 30.8 pints per diem. Daily cost at 3 ct. per pint = .03 × 30.8 = $0.924.

Annual cost under present conditions = 365 × .924 = $337.26. At 5 per cent this would pay interest on an investment of $6,745, which in turn would defray the expense of excavating 20,000 cu. yd. of earth. However, with the accepted alignment this yardage would not be sufficient to eliminate very much of the excess lift.

The loss of energy due to tractive resistance will next be considered. Observations made by the writer indicate that the present pavement has a resistance of 110 lb. per ton of gross load. For a gravel pavement in first-class condition the tractive resistance is lower, averaging 80 lb. per ton. However, the resistance of a hard, smooth pavement like brick or concrete is much lower. For example, a concrete pavement has an average resistance of 28 lb. per ton of load. Comparing a gravel pavement in good condition with the concrete pavement, we see that the daily saving of energy would be, for a traffic density of 200 tons, as follows:

(80 — 28) × 200 × 22522 = 234,228,800 foot pounds.

$$\text{Gasoline saved} = \frac{234{,}228{,}800}{1{,}980{,}000} \times 1.2 = 142 \text{ pints, nearly.}$$

Daily saving 142 pints at 3 ct. = $4.26.

Annual saving = 365 × 4.26 = $1,554.90.

This saving capitalized at 5 per cent represents the investment that would be allowable for concrete pavement. This amounts to $31,098. At $1.40 per square yard for 6-in. concrete slab, the cost of the hard surface pavement 9 ft. wide would be 1.40 × 22522 = $31,531. This is but little more than the allowable investment. A slight growth in traffic density would make up the difference.

On comparing the above result with Fig. 3, it will be noted that there is an apparent discrepancy between this result and that indicated by the chart. This is due to the fact, as will be readily seen by referring to Fig. 2, that the cost of concrete pavement falls considerably below the general average as indicated by the curve. Where close comparisons are desired, it will be necessary to perform computations similar to those indicated in the example.

The tentative character of the conclusions presented should be borne in mind. With the accumulation of more data, it will become possible to reach closer approximations to the final truth. Eventually it will become possible to replace the first cost of pavement with its ultimate cost. This will lead to greater consistency in results.

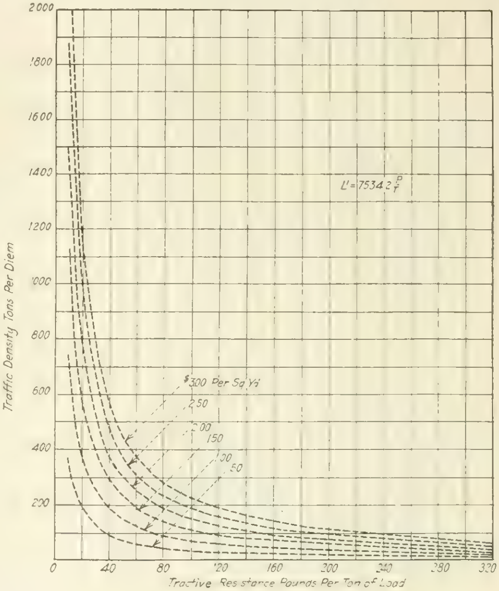


Fig. 3.

## Concrete Bases for Bituminous Pavements

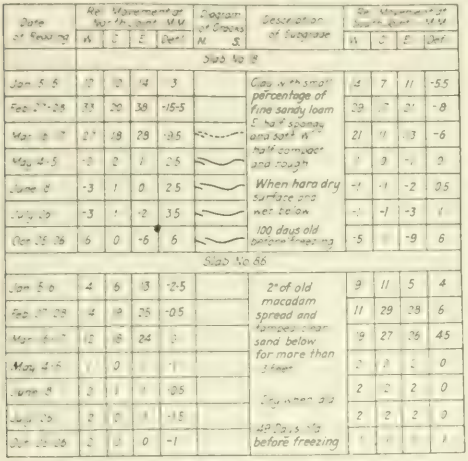
In a discussion at the recent convention of the American Society of Municipal Improvements, Mr. Wm. A. Hansell, Jr., superintendent of public works for Fulton County, Georgia, called attention to the necessity of giving proper care to the construction of concrete bases for bituminous and other pavements. The specifications for the Fulton County work require the use of the roller, as first introduced in Macon, and the securing of what is a reasonably good concrete road for the base. The expense of this improvement is comparatively small and the increase in the strength of the base is very great. By the use of the small wooden roller with bolt heads, or spikes projecting, the required roughness for bituminous concrete is obtained. If the finish is to be bituminous, the green concrete is given a bituminous paint coat, similar to that required by the county in finishing concrete pavement.

**Army of 1,500,000 Requires 40,803 Trucks.**—The amount of motorized equipment required for an army of 1,500,000 men, according to a statement of the Motor Transport Corps, includes 40,803 army motor trucks, 24,250 motorcycles, 7,905 passenger automobiles, and 6,598 ambulances. The total number of men required is 154,774. Of this number, 42,298 are officers, 30,000 non-commissioned officers and 34,000 mechanics.

# Vertical Movements in Concrete Pavements and a Suggestion Towards Their Elimination*

By J. W. LOWELL,
Division Engineer, Universal Portland Cement Co.

Early in the fall of 1916, the Universal Portland Cement Co. undertook to learn something definite about the vertical movements of concrete pavements. A stretch of newly built concrete pavement 3,325 ft. long and 40 ft. wide with integral curbs on Sheridan Rd., Kenilworth, Ill., was selected for the study. This pavement, 7 in. thick at the sides and 10 in. thick at the center, was of 2-course construction, the base being a 1:2½:4 pebble concrete and the wearing course a 2-in. thickness of 1:1:1½ concrete in which the coarse aggregate was granite from ¼ to ¾ in. Reinforcement consisted of No. 27 Triangle Mesh, wire fabric, weighing 41 lb. 100 sq. ft., placed between base and wearing course. One-half-inch round steel rods 14 ft. long, placed transversely 12 in. apart, 2 in. above the bottom, were used on the east half of the street as extra protection, a large sewer ditch having been built along this side for the full length of the improvement two years prior.



| Date of Reading | No. Movement of North Joint MM | | | | Diagram of Cracks N S | Description of Subgrade | So. Movement of South Joint MM | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | W | C | E | Def | | | W | C | E | Def |
| | Slab No. 8 | | | | | | | | | |
| Jan 5-6 | 12 | 8 | 14 | 3 | | Clay with small percentage of fine sandy loam E half spongy and soft W half compact and rough When hard dry surface and wet below 100 days old before freezing | 4 | 7 | 11 | -55 |
| Feb 27-28 | 33 | 20 | 38 | -15-5 | | | 29 | [illegible] | 21 | -8 |
| Mar 6-7 | 27 | 18 | 29 | -95 | | | 21 | 11 | 13 | -6 |
| May 4-5 | -2 | 2 | 1 | 25 | | | 1 | 0 | -1 | 2 |
| June 8 | -3 | 1 | 0 | 25 | | | -1 | -1 | -2 | 05 |
| July 26 | -3 | 1 | -2 | 35 | | | -1 | -1 | -3 | 1 |
| Oct 25-26 | 6 | 0 | -6 | 6 | | | -5 | [illegible] | -9 | 6 |
| | Slab No. 66 | | | | | | | | | |
| Jan 5-6 | 4 | 6 | 13 | -2-5 | | 2" of old macadam spread and tamped clean sand below for more than 3 feet Dry when dug 48 Days old before freezing | 9 | 11 | 5 | 4 |
| Feb 27-28 | 4 | 9 | 25 | -05 | | | 11 | 29 | 28 | 6 |
| Mar 6-7 | 12 | 6 | 24 | [illegible] | | | 19 | 27 | 26 | 45 |
| May 4-5 | 1 | 0 | [illegible] | -1 | | | 2 | [illegible] | [illegible] | 0 |
| June 8 | 2 | 1 | 1 | -05 | | | 2 | 2 | 2 | 0 |
| July 26 | 2 | 0 | 1 | -15 | | | 2 | 2 | 2 | 0 |
| Oct 25-26 | 2 | 3 | 0 | -1 | | | 1 | 1 | 1 | 1 |

Zero Reading Oct. 27-28, 1916

Fig. 1—Data as Grouped for Every Slab, Also Data on Typical Slab on Clay and on Sand.

**Character of Subgrade.**—The pavements having been completed before deciding to make our investigation, we were unable to make borings to determine the character of the subgrade. The engineer on the construction did, however, keep observation notes of the general appearance of the subgrade, and these records present a general description of the character of at least the surface subgrade soil. These notes were checked as well as possible by scattered borings along the sides of the pavement. From Slab 1 to 38, the subgrade may be described as a spongy, tough, compact clay; from 39 to 55, sand loam with spongy under stratum and compact crust; from 56 to 70, clay and loam, with some fine sand, the ground being spongy with sand below; and from 79 to 87, the south end of the pavement, sand greater than 3 ft. in depth.

The natural lay of the soil was, of course, broken up under the east half along the sewer, the excavation for which was about 2 ft. in from the east edge, from 8 to 10 ft. wide and 16 ft. deep. The subgrade surface appeared to be more compact on the west than on the east half which was badly cut up and rutted by teams. The ruts, however, were smoothed out as well as possible with sand, gravel and earth before concrete was placed.

The pavement was well built, excellent aggregates being used in correct proportions and well mixed. Proper precautions were taken in the hardening of the concrete and the last slabs were 38 days old before the air temperature dropped to 32° F.

**Work Preparatory to the Investigation.**—Just after completion of the pavement preparations were made for observation and study of the vertical movements of each of the 87 slabs, by a series of precise levels at three points on each side of every expansion joint. The points were taken 4 ft. from each curb and at the center, and permanently located by small holes drilled in the steel joint plates. The initial reading of each joint accurate to 0.1 mm. was taken on Oct. 27 and 28, 1916, and each reading reduced to 0 elevation, so that future readings would indicate directly the movement above or below the original position. Subsequent readings were not taken at definite intervals, but when weather conditions indicated that a change might be taking place in the subgrade. Eight readings were taken during the 12 months, the last on Oct. 25 and 26, 1917. Coincident with each reading a survey was made of the pavement surface and all cracks appearing were plotted.

Temperature and rainfall data were collected from the United States Weather Bureau Station at Chicago, 15 miles south of the pavement and in the same relative position with reference to Lake Michigan.

After collecting this mass of data, there being 4,176 elevations taken each requiring three rod readings, much work was necessary to put it into such shape that would permit of study, not only of individual slabs but of groups, and the whole. After several systems of grouping were tried the one shown by Fig. 1 was adopted. From this form army combinations were made. All measurements and computations were made in millimeters, but for the text of this paper these values have been converted into fractions of an inch.

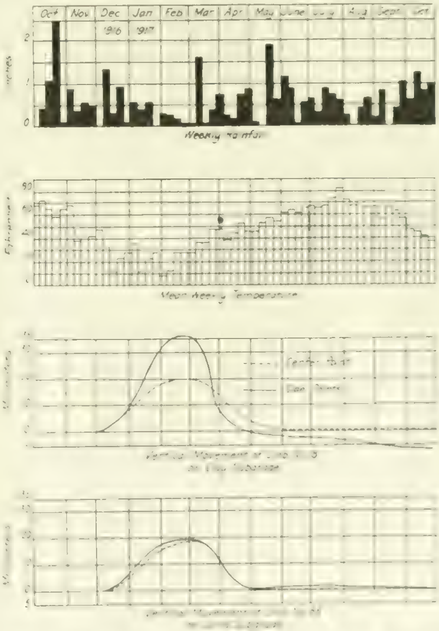


Fig. 2—Effect of Rainfall and Temperature on Vertical Movement.

**Cracking and Deflection of Slabs.**—Of 86 slabs, 56 cracked. Thirty-eight which cracked deflected at one or both joints more than 7/16 in. in the 32-ft. width between outside points, 18 less than 7/16 in. and of these 8 were between ⅜ and 7/16 in., while 4 slabs having as great deflection failed to crack. Six of the 10 remaining slabs which cracked, having maximum deflection of from ⅜ to 3/16 in. evidently cracked from abnormal settlement of a portion of the subgrade below the original level, leaving 4 slabs, one of which cracked at 3/16, one at 5/16 and two at 9/32 in., which defy explanation, unless the deflection had been greater at some period between readings.

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*[illegible]

Every slab reaching a deflection of more than 7/16 in. cracked and there were 38 out of 86, so it is safe to assume that such deflection in 32 ft. of width is sufficient to crack any pavement slab of this width built in accordance with present specification and practice. It is also evident that even greater deflection than 7/16 in. can be expected when the subgrade is clay or loam undrained.

Had the maximum deflection been less than 11/32 in., practically no longitudinal cracks would have occurred, and where the subgrade has a uniform moisture content the deflection would probably never be this great. This is substantiated by those slabs on sand subgrade.

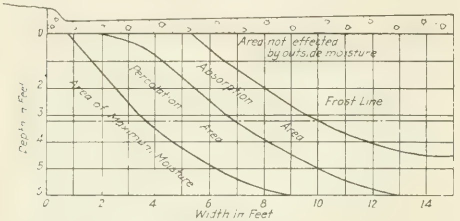

Fig. 3—Distribution of Moisture in Subgrade Such as Clay and Loams.

Thirteen consecutive slabs at the extreme south end of the pavement on sand subgrade acted quite differently and more uniformly than the others. The average upward movement was 11/16 in. on the west and 1 1/16 in. on the east side, while the center went 31/32 in. The greatest rise of any point was 1 15/32 in. The movements were so uniform that greatest deflection was ⅛ in. Unlike the other slabs there was practically no settlement below the initial reading, the greatest recorded being 3/32 in.

**Effect of Rainfall and Temperature on Vertical Movement.**—The movements of two typical slabs are shown in Fig. 2, together with the ranfall and temperature charts. Upon freezing the sides and center of these slabs at first began moving up uniformly. During this cold weather considerable snow fell and then during the first week in January a thaw occurred followed by extremely low temperature for the next eight weeks. In this period the sides of Slab 18 on clay subgrade rose more rapidly than the center until a maximum deflection of ⅝ in. occurred, while Slab 86 on sand subgrade rose but 6/10 as high, there being practically no deflection.

These concrete slabs were exactly alike, precipitation and temperature was the same, the only difference being in the character of the ground on which they lay. Since the subgrade is of inert material of similar nature, the only difference is in the size of the dirt grains. Without going into details of the relation of moisture in soils to their volume, it is permissible to state that the finer the dirt grains the greater the resistance to passage of water by gravity, the greater the change in volume for a given percentage of water contained and the greater the expansion of the mass on freezing. This statement is borne out by referring back to Slabs 18 and 86, the movements of which are shown in Fig. 2, No. 18 being on fine grained and No. 86 on coarse grained soil.

The assumption that the subgrade freezes deeper at the sides than under the pavement center is wrong, for concrete has about the same coefficient of conductivity as moist earth. In another investigation we have confirmed this by measuring the depth of frost at the sides and under pavements.

**Explanation of Cause of Heaving.**—The moisture content below the central portion of a pavement will probably never be much less than when the pavement is laid because there is no surface from which it can be evaporated. Since surface water from each side is conducted under the pavement both from static head and capillary powers of the soil, the moisture content will continually change from an almost uniform degree throughout to a maximum at the sides. Should the soil be compact a uniform condition is not probable at any time, while in sand the water has less resistance to its passage and so reaches a uniform condition quite rapidly. Fig. 3 is a study of the probable distribution of moisture under pavements on clay or loam subgrades.

Upon freezing the soil expands in proportion to the moisture content and since it cannot expand laterally it must expand vertically. The greater the difference of moisture from sides to center, the greater the distortion of the pavement slab. Snow falls upon the ground and afterwards a thaw occurs, melting it. If the soil is not fully saturated the water sinks down and spreads out under the pavement as far as it can go, by virtue of head and capillary powers, until it freezes in the voids at some depth where the temperature is still below freezing. In this way an impervious stratum is formed through which the water will not pass. The remaining surface water is afterwards held above this stratum, and this soil rapidly becomes more water soaked. If there is enough surface water the soil finally becomes saturated as far out as the water can spread by gravity and then the water content extends farther under the pavement, decreasing as the capillary power diminishes.

This action is finally ended by return of cold weather and subsequent freezing of all moisture accompained by expansion, which being restrained laterally acts vertically, but the vertical movement is proportional to the water (frozen) content above that amount required to fill the voids.

The vertical movement or heaving naturally is greatest at the sides where moisture is a maximum and decreases toward the center.

Concrete slabs are carried with the subgrade, wide slabs conforming to its shape because they do not have sufficient stiffness to carry their own weight. In this way distortion occurs, and when the deflection is such that the concrete on the extreme fiber exceeds its tensile strength a crack develops following the line of greatest deflection.

Pavements, regardless of width, should heave the same distance at the sides. Narrow pavements, those less than 16 ft. in width, should heave nearly uniformly because the moisture extends more uniformly toward the center. Pavements about 25 ft. in width should develop the greatest vertical curve, and above this width the curve should decrease with increasing width. It has been demonstrated, however, that pavements 40 ft. wide crack, which indicates that there is not enough decrease to bring the extreme fiber stress within safe limits, so this phase need not be considered.

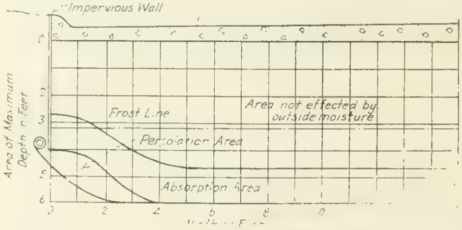

Fig. 4—Elimination of Moisture by Imprevious Wall and Tile Drain.

If cracks are to be eliminated, there are but two general solutions to the problem. One is to overcome the conditions as they exist by slab design; the other to eliminate the conditions by controlling the moisture content. The first scheme could no doubt be carried out in several ways, all of which would undoubtedly be expensive. An interesting and possibly less expensive solution is suggested by these experiments.

**Elimination of Moisture by Impervious Underground Walls.**—Variation in moisture can be eliminated by keeping water from percolating under the pavement. Although this is not a new theory it has as yet not been proven a success. Much money has been spent in vain on drain tile with and without porous backfill along the sides of the pavements, and why? Simply because they do not prevent the water from getting under the pavement either by pressure or capillary action. If results are to be expected there must be an imprevious underground wall along each side of the pavement extending down below frost level, and where ground water is present at least 1 ft. lower to keep capillary water below frost.

The nearest we have yet come to the suggested type of construction to eliminate heaving is the old style 36-in. deep curbing with drain tile laid outside, and no doubt such construction is satisfactory where ground water is well below the street surface.

A construction that might be as effective and cost less would be a ⅜-in. thickness of continuous jointed or lapped sheets of bituminous material such as is used for pavement joints, forming underground walls 4 or 5 ft. deep along each side of the pavement with 6-in. drain tile laid on a good grade just outside the base. Results that can reasonably be expected in clay or loam are illustrated in Fig. 4 in comparison to the study of probable conditions where no impervious wall exists.

Such construction would generally cost less than $1.25 a lineal foot, all of which need not necessarily be in addition to the present cost of concrete pavement for a considerable saving might be made on the pavement slab itself, in that reinforcing might be eliminated, thinner slab used and joints placed farther apart.

The investigation was conducted by Professor William H. Burger of the Civil Engineering College at Northwestern University, Evanston, Ill. This investigation is still under way on the Kenilworth pavement and also an independent investigation was begun last fall on Sheridan Rd., Winnetka, Ill. On this pavement we started in time to obtain subgrade borings before the pavement was laid and are conducting an analysis to determine the effect of moisture and freezing on various soils.

## Maintenance Cost of Bituminous Concrete at Portland, Me.

Maintenance costs for three sections of state highway constructed in 1908, 1909 and 1910, in the city of Portland, Me., are given in the last annual report of Edward M. Hunt, Commissioner of Public Works of Portland. The first section (completed in 1908) consists of bituminous macadam (penetration method) laid in Danforth and Vaughn Sts., for a total length of 2,879 lin. ft. and a yardage of 8,657 sq. yd. The cost was $1.13 per square yard. Section 2 covers 2,683 lin. ft. of bituminous concrete (mixing method) laid on Vaughn St. in 1909 at a cost of $1.03 per square yard. The total yardage is 8,807. Section 3 is also bituminous concrete. This was laid in 1910 on Cumberland Ave. at a cost of $1.31 per square yard. The total length of this section is 1,702 lin. ft. and the total yardage is 6,398. These pavements are maintained by the city. The unit cost of this for the past 9 years has been as follows:

| Date | Repairs per sq. yd. | Surface treatment per sq. yd. | Total per sq. yd. |
|---|---|---|---|
| Section 1 (8,657 sq. yd. bituminous macadam, completed in 1908). | | | |
| 1909 | [illegible] | $0.0000 | $0.0104 |
| 1910 | [illegible] | [illegible] | [illegible] |
| 1911 | .0080 | .0283 | .0363 |
| 1912 | .0083 | .0183 | .0266 |
| 1913 | .0111 | .0112 | .0223 |
| 1914 | .0113 | .0116 | .0229 |
| 1915 | .0070 | .0147 | .0217 |
| 1916 | .0122 | | .0122 |
| 1917 | [illegible] | [illegible] | .0176 |
| Section 2 (8,807 sq. yd. bituminous concrete, completed in 1909). | | | |
| 1910 | [illegible] | | [illegible] |
| 1911 | .0113 | .0102 | [illegible] |
| 1912 | .1521 | .0076 | .1597 |
| 1913 | .1148 | .0062 | .1210 |
| 1914 | .0111 | .0173 | .0284 |
| 1915 | .0057 | .0237 | .0294 |
| 1916 | | | |
| 1917 | .0027 | .0101 | .0128 |
| Section 3 (6,398 sq. yd. bituminous concrete, completed in 1910). | | | |
| 1911 | [illegible] | ..... | [illegible] |
| 1912 | .0702 | ..... | .0702 |
| 1913 | .1190 | ..... | .1190 |
| 1914 | [illegible] | [illegible] | [illegible] |
| 1915 | [illegible] | [illegible] | [illegible] |
| 1916 | [illegible] | [illegible] | [illegible] |
| 1917 | .0160 | [illegible] | [illegible] |

# General Phases of Street Cleaning*

**Purposes of Street Cleaning.**—From the economic or theoretical engineering side we should know whether we are cleaning streets for public convenience, for aesthetic reasons or for protection of the public health; or otherwise for what definite purposes these expenditures are made.

Undoubtedly the primary reason for street cleaning is for the promotion of public comfort or convenience. The annoyance of dust to the users of the highway and to those adjacent, as well as damage to property, may well be considered primary, especially if coupled with its wet condition as mud.

The second consideration, the aesthetic, may well have its weight, especially in elimination of rubbish, waste paper and larger debris which so offend our sense of propriety, but have little bearing on either health or comfort.

**Clean Streets and Health.**—The third consideration, that of health, may be one which should warrant extensive and expensive work in this line. The Street Cleaning Committee of the American Public Health Association, Samuel Whinery, chairman, in its report of about two years ago, after diligent inquiries and collection of practical evidence, strongly inclined to the opinion that, while theoretically there might be much danger from unclean streets, from the health viewpoint, there was little or no positive evidence of such. This opinion was largely based on lack of definite information that those engaged continuously in street cleaning and similar work suffered any ill effects from what might be considered as abnormal or excessive exposure to those conditions supposedly deleterious to health from street dust and similar influences. At least one member of your committee, from experience with local spring and fall epidemics of influenza and bronchial affections when street cleaning in northern cities is interrupted, is firmly of the opinion that the consideration of health may be well ranked as the most important factor in determining the extent of such work. Lacking, as yet, any definite conclusive evidence, it may now be assumed that cleaning, such as to remove fine dust and mud which may cause such, offers a reasonable task in street cleaning for comfort and health. The aesthetic considerations in removal of unsightly litter, unless the same be considered a source of dust by pulverization, may be given consideration to the extent which the locality may warrant in expenses.

The change from dry to wet methods of cleaning, now so increasingly evident, has a material bearing on the above considerations.

**Use of Motor Vehicles in Street Cleaning.**—From the practical or operative end of street cleaning, two phases stand out prominently as modifying practice; the substitution of motor vehicles for animal power and of flushing for dry sweeping.

The use of motor vehicles both for actual cleaning and for collection and hauling of municipal waste is but a phase of the general and increasing use of such vehicles, and must largely be a local question of economics, dependent in desirability of change from horse-drawn vehicles, upon loss of investment in existing equipment, length of haul, available funds and other local conditions. Apparently all plans for future development should contemplate the large ultimate use of motor vehicles.

**Substitution of Flushing for Dry Sweeping.**—The same change to serviceable motor vehicles has largely increased the practicability of flushing in cleaning. There were certain limitations to obtaining and maintaining adequate flushing pressure in horse-drawn vehicles.

In many cities the functions of street cleaning and sewer cleaning or sewage disposal are under somewhat separate supervision, and where such is the case there may well be required closer joint study of the problem as a whole for ultimate economy. Where no systematic gutter cleaning follows flushing, either the heavy street detritus is left in the gutters or is flushed into catch basins, and much of it ultimately into the sewers. We may, therefore, well bear in mind that this successful cleaning method may demand some modification in catch basin practice for protection of sewers. In combined sewerage systems we may reasonably expect some added expense in sewer cleaning, but where ultimate sewage treatment is given or required, as it soon will be in many cities, the question of the effect of the added burden on the detritus tanks or on the general operation of the whole plant must be given close study.

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*From the report of the Committee on Street Cleaning, Geo. H. Norton, Rudolph Hering and R. C. Harris, presented at the 28th Annual Convention of the American Society of Municipal Improvements.

One engineer of a large city says: "Cities having sewage disposal works find that the detritus from the streets somewhat complicates the question of sewage disposal. All of it cannot be handled in detritus chambers, except at very great cost." While such cost may be a material added burden to sewage treatment it is equally true that the cost of gutter sweeping or the dry removal of street dirt is a very large expense in dry street cleaning, and the engineering determination of an absolute combined minimum in expense presents one of those nice problems which we must solve. The solution is only possible through the collection of complete data and careful analysis. This would seem to offer an early and fertile field for study.

**Snow Removal.**—One other phase of street cleaning is of especial interest to the northern cities—that of snow removal, in connection with use of motor vehicles.

In case of heavy snow falls, usually the first streets opened to traffic are those containing surface car tracks, and the northern cities are mostly equipped to keep their tracks clear. The result is that motor vehicle traffic is at once diverted to these streets with resulting congestion and delay in traffic. The universal use of motor vehicles for all classes of traffic warrants the provision for its accommodation, and cities must be equipped and ready to keep thoroughfares open for this traffic while snow is falling and afterward to make viable streets.

Often the motor equipment provided for other phases of cleaning is most applicable and available for this work, and any consideration of motorizing in these northern cities should include the use and availability of such in solving the snow problem.

**Collection and Disposal of Rubbish and Garbage.**—The collection and especially the disposal, of rubbish and garbage, has been materially effected by war conditions.

The demand for utmost economy in these trying times has made it evident to cities not fully utilizing these sources of saving that they are to an extent wasting; that much of the various materials which would be of service to the cause are being wasted. But this has been so thoroughly impressed on the public that the individual economy in saving paper, rags and metals, and especially in squeezing the plethoric American garbage can, has most materially affected the various plants in operation for these purposes. The general individual saving and sale of rags, waste paper, etc., and more particularly, the very general elimination of grease content from garbage, make any studies of operation of these plants under present conditions of little comparative value unless we assume that the American public has learned lessons of economy which may be enduring.

More than a word of caution therefore should be given to those who may now study past and even present quantities and recoverable values in refuse that neither may safely be used for estimates of the future. No one can predict how far our lesson of economy under trying war conditions may be remembered or practiced under a return to what we may hope will be a condition of happy prosperity.

# Finishing Method for Concrete Roads

By E. EARL GLASS.

The finishing method illustrated in the photographs has been used satisfactorily on the construction of a number of highways in Southern California. A shovelful of thoroughly hydrated lime is put in the skip with each batch of materials. This permits the use of a dry or stiff mix of concrete which makes the strongest pavement and does not need a roller to remove excess water. As will be seen in the cuts, there is practically no excess water in this mix.

The finisher and his helper follow the templet with a long float. This is light but rigid and is faced with tin. It is worked from one edge to the other until no more material is displaced, the finishers standing on light box bridges as shown in Fig. 2.

This longitudinal floating assures a straight-edged surface in the direction of travel and consequently a smooth-riding pavement. The finisher then goes over the surface with a long-handled trowel, leaving it dense and smooth.

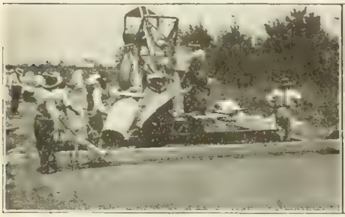


Fig. 1—Mixer and Tamping Templet.

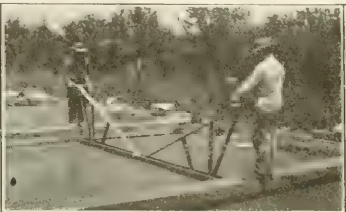


Fig. 2—The Float.

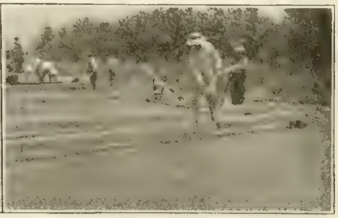


Fig. 3—Finish Troweling.

The lime makes the concrete work well under the finishing tools. Two men have no difficulty in completing 400 ft. or 500 ft. of 20-ft. pavement in 8 hours by this method.

## May Train Women for Motor Truck Drivers.

The task of assisting in recruiting men for the motor transport corps of the army, which is now being organized along such comprehensive lines as to call for a force approximating 200,000 men and for motor transportation of the value of $130,000,000 in addition to the value of such transport already in the service, has been assigned to the Highways Transport Committee, Council of National Defense, by General C. B. Drake, chief of the motor transport corps. In order to prevent the disruption which would follow if tens of thousands of skilled men were taken away from the great organization engaged in operating and maintaining the industrial transport service of the country, and at the same time to provide an adequate force, it is necessary to work out for the motor transport corps some plan to secure substitutes for those thus taken away. One way proposed for meeting this situation is by substituting women for men, which involves recruiting these women and placing them in training for service while the men in the industry are being withdrawn for army purposes. The possible selection and training of women to take the place of men in the handling of various kinds of highways transportation, and simultaneously the selection and training of men whose age makes them unavailable for army service, will be conducted on the basis that these people are volunteers in much the same sense as are those who are entering the army.

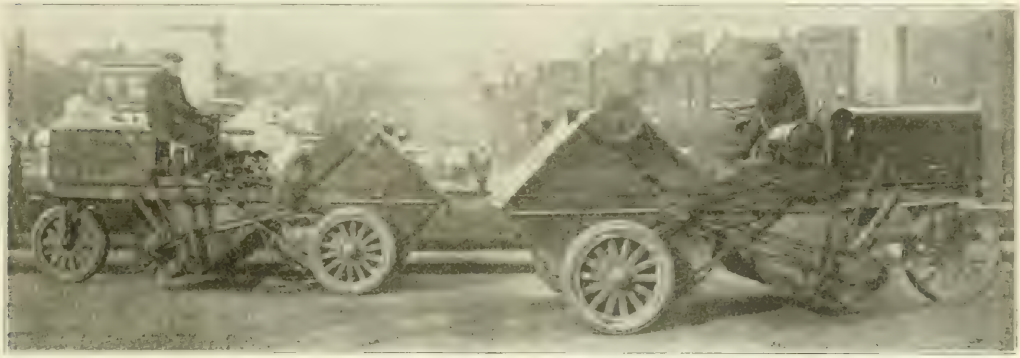
**Convention of Kentucky Highway Engineers' Association.**—The annual convention of the Kentucky Highway Engineers' Association will be held Nov. 12, 13 and 14 at Owensboro, Ky. The convention will be somewhat different from previous ones. Only a few addresses will be made indoors. Practically everything that pertains to the building and maintenance of roads will be discussed in the open air right on the road where the work is in progress.

# Street Cleaning at Buffalo with Motor Apparatus

Motorized outfits are used to a large extent in street cleaning work at Buffalo, N. Y. Interesting data on the operation of these outfits were given by Mr. William F. Schwartz, Street Commissioner, in a paper presented at the recent convention of the American Society of Municipal Improvements. The notes following have been abstracted from Mr. Schwartz's paper:

**Motor Sweepers.**—The city at the present time has two Elgin motor sweepers. These sweepers were placed in operation on Oct. 1, 1916, replacing 6 horse-drawn sweepers and two sprinkling wagons. They work two shifts 8 hours each per day, namely 3 a. m. to 11 a. m. and 4 p. m. to 12 p. m. They are a combination sprinkler, sweeper and pick-up, being equipped with a 200-gal. tank, large circular broom, and 1½-cu. yd. box. The motive power is a 45 H.P. engine.

During the fiscal year ending June 30, 1918, they cleaned approximately 72,000 great squares (great square, 10,000 sq. ft.). It was found they did the best work on smooth pavement, and that the cost per great square was about 2 ct. lower than in horse-swept districts. On account of the abnormal times there was considerable trouble in getting competent drivers, consequently the machines have not been worked as satisfactorily as under normal conditions.



Elgin Motor Street Sweepers of Buffalo.

**Motor Flushers.**—During the past year three motor street flushing equipments were installed by the department to replace the old method of flushing and in some districts street cleaning. In constructing and designing this equipment the department took into consideration, 1st, cost of equipment; 2nd, length of time of service; 3rd, operation and maintenance; 4th, size.

From the above was specified a 5-ton tractor with power take-off from transmission to pump that delivers pressure for flusher; a trailer with 2,000-gal. tank capacity set upon the fifth wheel on tractor. Tractors in operation are the 5-ton Pierce-Arrow of standard design, with exception of power take-off of 15 H.P. and are geared 42 to 1. The tractors are equipped with dual 36-in. tires rear, and single front.

The trailers and pumps are manufactured by Chas. Hvass & Co., of New York City, and are provided with cylindrical tank, four nozzles which are controlled from driver's seat, centrifugal pump driven from power take-off, also controlled from driver's seat. The pump creates a pressure of 35 lb. (This pressure can be increased or decreased.) It is found at Buffalo that 35 lb. will not injure the pavement and at the same time does cleanly work. When the street is very dirty the four nozzles, which gush 525 gal. per minute, are used, but as a rule only two nozzles, which flow 150 gal. per minute, are used. During the process of flushing, tractor runs at a speed of 4½ miles per hour; running empty 14 miles. The weight of tractor and flusher when full is 18 tons, when empty, 10 tons.

**Flusher Tractors in Snow Removal Work.**—During the winter season the trailers are removed from tractors, and the tractors are placed in operation in snow work, also hauling trailers for ash and garbage districts. It is estimated that during the past winter these three tractors saved the city at least $15,000 in snow work alone. A great many of the streets in the outlying districts became drifted, and it was an utter impossibility for the city to get labor to take care of the same, notwithstanding the fact that every available prisoner that could be commandeered from the penitentiary was employed. The tractors were equipped with "Good Roads" snow plows and they did excellent work.

**Cost of Flushing.**—The cost of operation per day (which includes operating charges, maintenance and fixed charges) for a 16-hour day was $24.96. During the winter months this cost increased $2.00 per day on account of more gasoline and oil being used by being forced to run low gear the greater part of the time on account of bucking heavy drifts of snow.

Under the old system of flushing with portable line hose the cost per great square of 10,000 sq. ft. was $1.40. With the two-man reel the cost was 56 ct. The motor equipment reduced the cost to 20.5 ct. per great square. This includes everything, such as operating labor, supervision and pick-up wagons.

The city has contracted for three additional flushers, and it is the intention of the department as soon as financial conditions warrant eventually to do away with all horse-drawn sweepers and sprinklers and flush the entire town with the exception of cobblestone and macadam pavements, as it is found that the cost per great square for sweeping is $0.278 and that of flushing is $0.205. The latter is not only more economical but leaves the streets in a more cleanly condition besides being more sanitary.

**Ash and Garbage Collection with Motor Equipment.**—For two months experiments were made with trailers and tractors in the Ash and Garbage Division and it was found that these would cut the expense approximately 25 per cent and also give greater efficiency. The system followed in the demonstration was to start empty trailers drawn by horses from various barns to the different districts. When these trailers were loaded tractors with train of four empty trailers dropped the empties, took up loaded trailers and proceeded to dump or reduction plant, continuing this operation until districts were cleaned up.

At the present time there are six Ford motor trucks in operation in the Ash and Garbage Division. These trucks have a capacity of 4 yd., but have been in operation for only four months, consequently it is not possible to get a definite line upon the maintenance and depreciation. The drivers are inexperienced, being mainly boys of 17 to 19 years of age, so that these trucks are often laid up for repairs. It is intended to motorize the entire Ash and Garbage Division after the war.

## Method of Repairing Asphalt Pavement at Buffalo, N. Y.

During the last 15 years the Department of Public Works of Buffalo, N. Y., has been responsible for the annual maintenance of about 3,000,000 sq. yd. of asphalt pavement. The methods employed in repairing this pavement were described by C. E. P. Babcock, First Assistant Engineer, and J. A. Vandewater, Assistant Engineer, in charge of repairs, in a paper presented at the recent convention of the Ameriacn Society of Municipal Improvements. An abstract of the paper follows:

The principal factors in the asphalt repair specifications are:

Both top and binder are purchased at the plant of the contractor by cubic measure, the price including delivery on the work.

The asphaltic cement for painting joints is paid for by the gallon, delivered.

The cost of the street work includes labor, the chopping out of patches, laying material and cleaning up. This is paid for by the square yard.

The contract provides for relaying concrete base, unless the city performs the work with its own forces. It also provides for paving in trenches with binder 1½ in. deep and top 1½ in. deep and labor—a price being bid: for trenches under 80 sq. yd.; for trenches between 80 and 480 sq. yd.; for trenches between 480 and 1,000 sq. yd.; for trenches over 1,000 sq. yd.

If two or more trenches of this kind are within ½ mile of each other and are repaired as a continuous work, the sum of their area is the area on which payment is made.

By this specification the city uses all of either the binder or the top as its engineer requires and pays for the amount actually used. The average depth experience has been: binder 1.12 in., top 1.57 in. of 75 and 78 per cent of original depth.

In the 1917 work it was found that about 0.87 in. average depth of binder and 1.57 in. of top, or 58 and 78 per cent respectively were used. The reduction in binder was partly due to the fact that the pavements are becoming thin. Those laid prior to 1892 were laid on ½ in. cushion instead of binder, and these require little, if any, binder in repairs. The specifications provide that when the old pavement is less than 2 in. deep binder shall not be used for repair.

Bids for repairs are received early in the calendar year, enabling the contractor time to order his material and to arrange his organization.

As soon as the weather permits, usually in March, an inspection of all pavements is made, conditions noted, and a list of streets to be repaired is prepared, streets in the down town or business section and the principal thoroughfares being taken care of first. An attempt is made to repair all the asphalt pavements at least once a year and this has been done with a few exceptions. Pavements that have unusually heavy traffic are repaired twice a year when necessary.

Work is begun about April 1st and usually continues until about Dec. 1st. The pavements to be repaired are marked out by an asphalt locator, who is assisted by boys who measure up and locate the patches, and a man to record same in field book. The contractor also furnishes a man to keep a record of the size of the patches and his record must correspond with those made by the city's locator. The repair gang then follows, chopping out, relaying the new material and cleaning up. A gang lays from 750 to 1,000 sq. yd. per day, depending upon the size of the patches. All old material is the property of the city and is removed to a dump provided by the contractor or wherever the engineer may direct.

The work is done by two large gangs consisting of about 75 to 100 men each, foremen, teams, trucks and rollers. There is also a small gang employed repairing cuts made by the Bureau of Water, plumbers, corporations and others.

In 1917 a gas driven cutting machine, having an action similar to that of a pile driver, was devised by one of the contractors to cut out patches. It is not altogether satisfactory, particularly on old pavements where it often breaks contiguous pavement. The experience, however, is not sufficient to warrant an extended criticism. A rather specious argument for its use is that it acts as a sort of balance wheel for labor and axes, when the labor looks for higher wages; but for good workmanship the engineers have not found a mechanical cutter that compares with a man and axe.

The contract price has varied from 74 ct. to $1.39 per square yard laid up to Dec. 31, 1917, and, on account of the high cost of labor and material this year, the rate may run somewhat over $1.80 per square yard laid.

## Circumferential Rods Used as Auxiliary Reinforcement for 55 ft. Wide Concrete Pavement

In the construction of ¾ mile of 55 ft. wide concrete street pavement at West Frankfort, Ill., special precautions were taken to overcome any tendency toward cracking because of the extreme width or the nature of clay sub-base. Increased strength was provided in the slabs at the joints, states the Concrete Highway Magazine, by placing, in addition to the mesh reinforcement, three ¾-in. rods half way between the finished surface and the base of the pavement. The pavement is 6 in. thick at the sides and 9 in. thick at the center. The rods were placed on each side of the joint and perpendicular to the center line of the pavement. The first rod is 8 in. from the joint, the second 14 in. from the first, and the third 16 in. from the second. The rod next to the joint is 50 ft. long and the others are 40 ft. and 30 ft. long, respectively. Steel mesh reinforcement is placed 2 in. below the finished surface of the pavement and over the entire area of the slab.

## Steam Shovel Work in Road Construction

The State Roads Commission of Utah is employing steam shovels on heavy cuts and side hill work in connection with road construction projects. On one job in Weber Canyon, near Henefer, a Bucyrus Model 18-B, working on side-hill cuts for roadway, moved about 400 cu. yd. per 8-hour shift for several days. The material was about 35 per cent earth and 65 per cent boulders, ranging from 6-in. to 3 ft. in diameter or even larger. Some of the larger boulders were broken with blasting powder ahead of the shovel. The total operating expenses per 8-hour shift were as follows:

| | |
|---|---|
| Team and wagon | $ 6.00 |
| Steam shovel engineer | 6.00 |
| 3 men at $4.00 | 12.00 |
| Field engineer | 6.00 |
| Coal | 4.00 |
| Oil | 1.00 |
| Total | $35.00 |

Taking into account the time lost for occasional repairs, a unit price of 10 ct. per cubic yard was obtained on the greater part of this work.

This steam shovel operation, states Mr. Ira R. Browning, Secretary and Engineer of the State Road Commission, to whom we are indebted for the matter in this note, was more effective and more economically performed than the average steam shovel excavation that has come under his observation. Under like conditions on both the state road work and on side hill excavation for other purposes, a unit price of from 15 ct. to 20 ct. per cubic yard has obtained.

Steam shovel work in Willow Creek on the Castle Gate-Duchesne post road, Carbon County, Utah, had the following quantities in the July estimate, 1918:

| | Cu yd. |
|---|---|
| Earth | 3,500 |
| Loose rock | 1,000 |
| Solid rock | 1,800 |
| Total | 6,300 |

The pay roll covering this work, including blasting the ledge rock and large boulders and some leveling and finishing of the grade, amounted to $1,283.25, giving a unit price of 20 ct. per cubic yard.

# Washing and Screening Plant for Aggregates for Concrete Road

Difficulties in securing suitable aggregates for the construction of 6¼ miles 20 ft. wide concrete road in King County, Washington, were solved by erection of a washing and screening plant by the contractor. The plant has several novel features, which are described by Mr. C. P. Mowry, Office Assistant to King County engineer, in the Concrete Highway Magazine, to which we are indebted for the matter that follows.

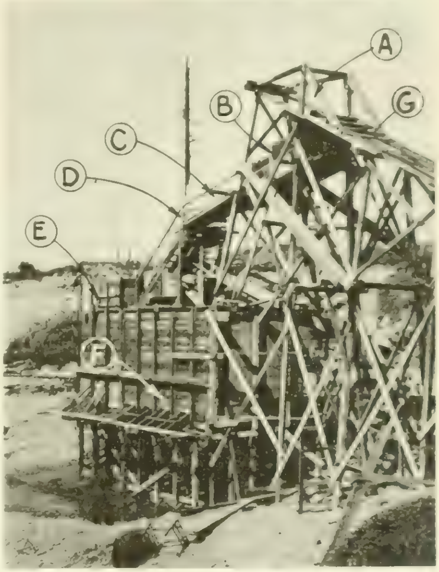
The pit which was finally decided upon to furnish aggregates lies near the right of way of the road about midway of the contract, but the nearest water supply is 1½ miles away and approximately 100 ft. lower in elevation than the pit. Here the pumping plant was located, which consists of one 4 by 4-in. triplex pump with 2½-in. suction, one 3 by 4-in. duplex with 2-in. suction, driven by two 6 hp. gas engines and discharging into a force main about 1½ miles long, of which about 1,000 ft. is 6-in. wood stave pipe, the remainder being 4-in. wood stave pipe. The combined delivery of these pumps is stated to be approximately 50 gal. per minute, working against a head of 90 lb. per square inch at the bunker end. The main discharge is used first to obtain clear water under pressure for the final washing, surplus being discharged into a clear water reservoir.

The principal equipment at the gravel pit consists of one Bagley drag line scraper of 1 cu. yd. capacity, operated by a 7 by 10¼-in. double drum hoist, a 1-cu. yd. skip, a pebble and sand bunker having a capacity of 90 cu. yd. of pebbles and 30 cu. yd. of sand, a timber settling basin for dirty water about 20 by 30 ft. and 3 ft. deep, with an 80-ft. settling flume 2 ft. wide carrying 8 in. of water passing over several timber catch basins. There is also a gasoline pump located near the bunkers to pump water from the settling basin to the first washing flume of the plant, and a clear water reservoir located on the plant above the pebble bunker and receiving clear water from the pumping plant. This reservoir has a capacity of about 13 000 gal.

Materials are excavated by means of the drag line scraper and deposited upon a timber trap built over the lower end of the incline carrying the skip. The skip hoist conveys material to a grizzly at the head of the washing plant located above the pebble bunkers, where over-sized material is separated and returned to the waste dump. The first washing is given at the grizzly by a stream of water amounting to 200 gal. per minute, pumped from the settling tank by a 10-hp. engine under heavy pressure, washing materials along a flume about 16 ft. long, 2 ft. wide and 18 in. deep, at the bottom of which riffles are placed. At the lower end of the flume, pebbles are discharged upon a coarse screen which is backed by a screen of ¼-in. mesh, set about 6 in. behind. Sand mixed with the pebbles passes with the washing water through the fine screen directly into the sand washing box, while the pebbles are directed through a chute into their bunker. As the pebbles pass down along the fine screen, they encounter a series of powerful jets of clean water coming from a 2-in. pipe drilled with small holes and receiving the water supply directly from the force main leading from the pump located at the pumping plant. These jets retard the movement of the pebbles appreciably and thoroughly wash from them any organic matter or clay which may have remained adherent after having passed the first flume.

The sand box is shaped somewhat like a small bunker and has a sloping floor. It is 4½ ft. square, 5 ft. high, and is pivoted upon a heavy piece of pipe as an axle, with a counterweight consisting of a box filled with large stone. Near the bottom of the front vertical face are two short sections of 3-in. pipe attached to a timber box by means of standard flanges. The outer ends of short pipe, when the sand box is empty, bear against leather washers attached to the timbers, which serve as stoppers. The principle of the sand box is that when filled with water, but containing no sand, the counterbalance holds the box in position and the pipes bearing against the timber prevent outflow of material. When sand accumulates in the box to a convenient depth which may be regulated by stones in the counterweight, the box automatically tilts downward, moving the outlet pipe below the lower level of the timber, permitting accumulated sand to flow into the sand bunkers.

Close to the bottom of the tipple box there is another section of pipe, drilled with holes, pointing upward, through which jets of clean water are continually forced under high pressure, which further cleans the sand. The overflow from the sand box is conveyed to the settling flume and tank, where it is allowed to clear before again used. As a final precaution to securing clean material, outlet chutes from the pebble bunkers have floors of ¼-in. mesh screen and directly above the chutes is another series of 2-in. pipe, drilled with holes, to direct jets of clean water downward through the pebbles as drawn into motor trucks.



A—First Washing. Water Supply 200 gal. per Minute at This Point. B—Rejections from Grizzly. C—Flume and Riffles. D—Screen Separates Sand from Pebbles. E—Sand Washing Box. F—Pebble Bins. Pebbles Receive Final Washing Here. G—Skip Hoist.

Since the development of the plant as described, samples of the material submitted to the colorimetric test show practically a clear liquid, and standard briquets made with a mixture of 1 part cement to 3 of sand show an average tensile strength for 7 days of 292 lb. per square inch, while the same cement used with standard Ottawa sand showed 251 lb. at 7 days.

# Old Elevator from Crusher Outfit Used in Loading Stone into Wagons

An old elevator taken from a rock crushing outfit was successfully employed last season by the County Road Superintendent of Holdimand, Ont., for loading broken stone from cars into wagons. A trench was cut between the rails and the stone dumped through the pockets in the bottom of the car into the trench. The stone was conveyed from the trench to the wagons by means of an elevator and chute, the elevator being driven by a 6 H.P. gasoline engine. This method worked very satisfactorily and without interference to anything, the end of the siding being used for the purpose, the car, when necessary, being moved so that a pocket would be over the trench. A wagon of 2 cu. yd. capacity was loaded in three minutes and two 50-ton cars were unloaded in a day. The entire outfit consisting of an engine, elevator and bin, and the erection and taking down of same, cost approximately $260.

# Maintenance Cost of Asphalt Pavement at Buffalo, N. Y.

Detailed records of asphalt pavement repairs have been kept for many years by the city of Buffalo, N. Y. These records were started when the guarantee on the first pavement expired and its maintenance was taken over by the municipality. Interesting information on asphalt pavement maintenance, obtained from the experiences at Buffalo, was given in a paper presented Oct. 3 at the convention of the American Society of Municipal Improvements by C. E. P. Babcock, First Assistant Engineer, and J. A. Vandewater, Assistant Engineer, in charge of repairs of the Public Works Department, Buffalo.

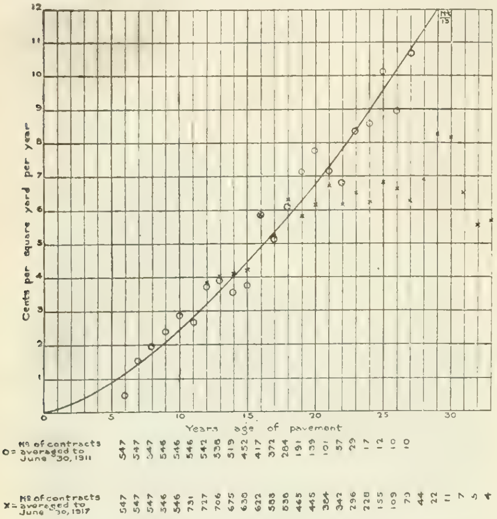


Fig. 1—Average cost of repairs per square yard on all sheet asphalt pavements at different ages to date of condemnation—with curve $\frac{N^2}{13}$. Pavements laid previous to 1898 on 5-year guaranty—after on 10-year guaranty.

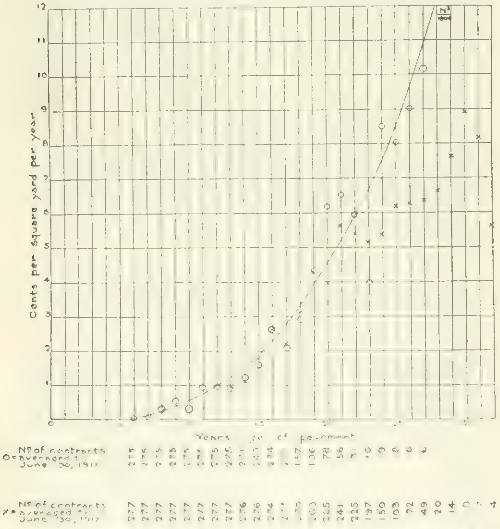


Fig. 2—Average cost of repairs per square yard on asphalt pavements without car tracks where streets were fit and well constructed—with curve $\frac{N}{1800}$.

During the last 15 years, or up to June 30, 1917, about 3,000,000 sq. yd. of asphalt pavement have been maintained annually; the greatest number of square yards being 3,139,731 in 1911, and the least, 2,858,634 in 1916.

The average cost per square yard on total yardage maintained has varied from $0.0162 in 1903 (due to the small appropriation available that year for this purpose), to $0.0827 in 1913—the average for the last 15 years was a little over 5 ct. per square yard. This rate, however, does not represent the necessity of repair which the department might rcommend, but is influenced by the funds available. The last 5 or 6 years the appropriation for this purpose has been very fair.

Up to June 30, 1917, $2,899,781 has been expended on repairs to asphalt pavements. The average rate per square yard in area of the streets repaired was $0.0653 and on the area maintained $0.0451. 64,300,000 year yards repair of paving, carrying 5-year guaranty prior to 1898 and 10-year guaranty on pavement laid since 1898, show an average annual rate of $0.045 per square yard. The present average age of all asphalt pavements under city maintenance is about 21.7 years.

The accompanying diagrams, Figs. 1 and 2, show the average cost of repairs. These curves were first prepared in 1912 by Capt. George H. Norton, City Engineer, and have now been brought up to 1917.

## Snow Removal from Motor Convoy Routes

The Highways Transport Committee, Council of National Defense, which co-operated last winter with various State Highways Departments in the removal of snow from motor convoy routes extending over north and middle western states to seaboard, is now preparing to undertake this important work during the coming winter. The State Highways officials of Pennsylvania, New York, Ohio, Illinois, Indiana, Michigan, New Jersey, Massachusetts, Connecticut, Delaware and Maryland, which co-operated with the Highways Transport Committee and the War Department most effectively last winter, will be called upon again to aid in planning the snow removal program now being arranged. The Legislature of New York has provided the State Highway Commissioner with a fund of $50,000 to be used in helping to keep clear of snow those roads to be used by Government trucks. An organization which will extend down to the State, District, county and community organizations, of the Highways Transport Committee, is being formed to co-operate with the war department and the State Highways Commissions in bringing about the results to be desired. The Highways Transport Committee has arranged with Prof. Charles S. Marvin, Chief of the Weather Bureau, to have forecasts made from different observation points in the territory expected to be covered by these motor truck routes, at least three days in advance of the starting of the trains. In this way it is hoped to be able to anticipate coming snowfalls in such time as to make it possible to guard against them.

**Concrete Guide Posts for Wayne County Highway System.**—The County Road Commissioners of Wayne County, Michigan, has begun the systematic marking of its highway system and already has expended $5,000 for this purpose. The guide posts, which are erected at each important intersecting road in the system, are of reinforced concrete set on a concrete foundation. Each is 10 ft. high and the road signs are securely fastened to the concrete posts by metal brackets. These highway markers are to take the place of all signs and boards which are attached to telephone poles or other supports now on the road right of way and giving distance to the next town, often incorrectly. It is the intention of the County Road Commission to clear all other road signs and billboards from the highway right of way.

# Tile Foundation for Overcoming Destructive Action of Frost on Hard Surface Pavements

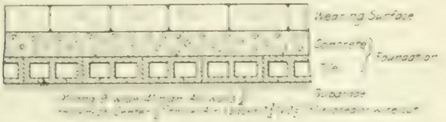
A new type of foundation, designed to prevent longitudinal cracks in hard surface pavements, was described by Mr. Wm. C. Perkins, Chief Engineer, Dunn Wire-Cut Lug Brick Co., Conneaut, O., in a paper presented Oct. 3 at the convention of the American Society of Municipal Improvements. The foundation, which was designed by Mr. Perkins, is described in his paper as follows:

"Upon the earth, or prepared subgrade, lay a course of two-duct tile 4-in. in height, outside measurement. The surface measurements could be any standard size, but I would suggest 8½ in. wide by 12 in. long. They may be made of any desired material, such as concrete, vitrified shale or clay, and of any shape or form.

"Complete this foundation with 2 in. or 4 in. of concrete or other suitable material. We have then prepared a 6-in. to 8-in. foundation upon which to place our wearing surface of any standard paving material—brick, block, concrete or bituminous.

"By the use of the tile in the artificial foundation, we endeavor to minimize the force of the upward pressure of a frozen subgrade:

"(1) The tile acts as a non-conductor of heat between the ground and the paving; the air within the ducts of the tile serving as a non-conductor prevents the frost from penetrating through the pavement to the subgrade. In many sections this type of construction may prevent actual freezing of the subgrade, while in extreme northern sections it will materially reduce the freezing.



Cross Section of Pavement With 2-Duct Tile Foundation.

"(2) When the earth, or subgrade, does freeze, notwithstanding the heat insulation of the tile, we believe that the upward pressure of the frozen subgrade would be dissipated by the eventual breaking of the tile, and that the force, or explosion, would be compensated by the air space and not be transmitted to the paving above. In case the tile be too strong to break under pressure of a frozen subgrade, the bottom of the tile, under the air spaces, could be "scored," thus providing a weak spot to break under this upward pressure. The superfoundation and the wearing surface would be sufficiently strong to bridge over any breakage of the bottom of the individual tile under the air-space sections, since the walls and partitions of the tile would remain intact and would afford ample support to the superfoundation.

"(3) The tile would also act as drains to carry off any ground water or water drawn into them by capillary action, thus lessening the hazard of cracking due to the upward force exerted by frost in the subgrade.

"The tide may be laid longitudinally, transversely or diagonally.

"If laid either transversely or diagonally, the water would be carried to the curb or edge, where it can be taken care of by means of longitudinal drains or French drains of gravel or stone.

"If the tile are laid longitudinally the water can be taken care of at regular intervals by cross-drains of tile or by French drains of gravel or stone.

"The grade and cross-section of the improvement would determine these details.

"It is difficult to estimate comparative prices in these abnormal times, but basing estimates on available data, the 4-in. tile should not cost more than 4 in. of concrete in place, and if constructed as suggested the tile and concrete foundation should be able to carry at least the same load as if the foundation were entirely of concrete or of a material of equal load-bearing strength.

"The type of foundation I have suggested as a means of preventing longitudinal cracking of hard surface pavements is the result of study and experience, and while it has not been subjected to the final test of practical service under all kinds of climatic and traffic conditions, I have sufficient faith in its utility for the purpose designed to have the type of construction protected by patent."

# Buffalo Planning for Post-War Improvements

Buffalo, N. Y., is one of the few cities in this country that has taken action toward formulating a broad constructive policy regarding after-the-war public improvements. On July 31, the city council adopted unanimously the following recommendations submitted by Mr. Charles M. Heald, Commissioner, Department of Financial Accounts:

Two major problems now confront our country.

1 The winning of the war.

2 The restoration of pursuits of peace when the war has been won.

Of course, at the present time the first problem overshadows the second but the nearer we approach victory on the battlefield, the larger will loom the importance of the second problem If we can contribute much to the solution of the second problem without detracting one iota from the first, viz., decisive victory over the enemies of democracy, so much the better. In so far as expenditure of capital and employment of labor for public improvements are concerned, the two problems are related so closely that in properly solving one we contribute largely to the solution of the other.

Without any thought of an immediate peace, the National Government is already concerned with the problem which will be presented by the disbanding of the army. The men who are now fighting in France will have to be absorbed in useful occupations, and the men and women who are now engaged in war industries in Buffalo will have to be provided with opportunities for employment in the walks of peace. We will then be face to face with the necessity for a colossal readjustment.

This city has a large margin between its bonded indebtedness and the limit imposed by the State Constitution, about $30,000,000 in fact. Our financial condition after the war will be adequate to take care of any reasonable improvement program. By formulating such a program in advance and being prepared to execute it without delay when the time comes we will have done much toward solving our "after-the-war" problem. Such a program should include grammar school construction, street paving, sewer construction, water main extension, the erection of a city office building, river and harbor development, and any other improvements which will contribute to the peace and happiness of our people.

I would, therefore, respectfully recommend that the Council submit all new work to the test herein referred to before authorizing expenditures, whether the money is to be raised by bond issues or taxation, and I would further respectfully recommend that the head of each major department be requested to submit to the Council not later than Nov. 1 a comprehensive statement of public improvements, which his respective department considers as properly belonging to an "after-the-war" improvement program; and I would further recommend that the Board of Education be and is hereby requested to submit to the Council not later than Jan. 1 next a statement of the number and size of grammar schools which, in the judgment of the Board, should be erected as soon as the war has been won

# Method of Raising Sunken Pavement Slabs to Grade

The settlement of a fill in a concrete road in Chelan County, Washington, caused the ends of two abutting slabs on one expansion joint to sink about 4.8 in. The slabs were restored to grade line by the following method: The dirt was removed from underneath the point of settlement for half the width of the pavement and to a depth of about 3 ft. Eight 2½-in. and 3-in. jacks resting on two 3-in. planks were placed in the excavation. Two 3-in. planks were placed on top of the jacks to distribute the load equally. The slabs were gradually raised until the tops were at grade line. The dirt was then placed under the slab and well rammed into position. A fine longitudinal crack developed in the center of the panels raised, after the work had been completed, but otherwise there was nothing to indicate that the slabs were not as good as new. The work was carried out under the direction of Mr. F. M. Berry, County Engineer.

# Application of Pneumatic Drills for Making Pavement Cuts

The removal of asphalt, concrete or block pavements by hand work for opening streets for underground mains is a relatively expensive job. Of late pneumatic drills have been applied in this work, with excellent results. An excellent summary of the use of these tools for opening pavements is given by Mr. H. L. Hicks in Compressed Air Magazine, from which the following notes have been taken.

**Making Cuts in Concrete Pavement.**—In Des Moines, Ia., electric service lines were to be laid in underground conduit. By hand methods it had been necessary to remove whole panels of concrete paving, in spite of the fact that a narrow trench was all that was needed. The engineer introduced the jackhamer and it was demonstrated that by using the air drill it was possible to restrict the cutting to a strip about a foot in width; a decided saving in the amount of pavement torn up. Hand work would have cost about 40 ct. per foot. With the introduction of two drills and an electric portable compressor it was estimated that the figure could be cut to 30 ct., but actual results showed a cost of 18 ct. per foot.

In cutting concrete, under such conditions as in the subway construction in New York City, where the problem has been merely to tear out paving, foundations and other concrete without blasting, it is common practice to use a pointed chisel rather than the usual rock drill bit. As the rotation of the steel is unnecessary, shanks are made round instead of hexagonal. This, of course, renders the automatic steel rotating action of the drill superfluous. The chisel bit is very effective where concrete is of 3 or 4-in. thickness, as it permits the wedging and breaking off of relatively large chunks.

The problem of concrete pavement cutting has led to the adaptation of other air tools to the work. On part of the subway work, above mentioned, a heavy riveting hammer, when fitted with suitable chisel, was found an excellent pneumatic pick. In other cases the pneumatic tie tamper has been fitted with a sharpened pick and developed into a conveniently handled concrete remover. In removing concrete pavement preparatory to replacing the rails of a Chicago street railway, a strip 6 to 8 in. wide was torn out at a rate of 30 ft. per man per hour. Average performance reports indicate that pneumatic equipment will better the working speed of a gang of twice as many men using hand picks.

**Removing Asphalt Paving.**—For this service the tie tamper is a time and labor saver. A flat chisel of about 3 in. width is used. First the pavement is scored with the tool in an inclined position. Then it is held upright and the paving cut through and pried up. This method of applying tie tampers was developed by the street railways and shows such excellent saving that it will be undoubtedly applied by municipal contractors to similar work. At Elmira, N. Y., four men removed approximately 600 sq. ft. per hour, at a fraction of the cost of hand work.

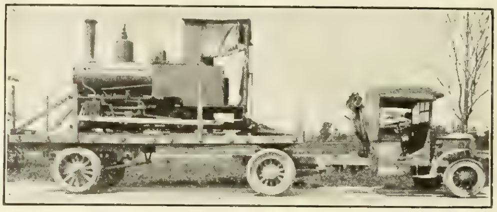
Another tool also used for the same work is a smaller hand pick. With this tool narrow grooves are cut, marking the portion of the asphalt to be removed, at an average rate of 20 lin. ft. per hour.

**Removing Bitulithic Paving.**—Bitulithic pavement, being softer and of somewhat sticky nature, is removed in a slightly different manner. A chisel some 1½ or 2 in. in width is employed to make a series of cuts, each the width of the chisel and spaced about 2 in. apart. Cuts of just sufficient depth to mark a distinct cleavage line are made on one side and the ends; the pavement is cut through on the remaining side, a crowbar is slipped under and the block or slab of pavement pried out. At Portland, Ore., pavement of this kind was removed in slabs 4-ft. x 4½ ft. at a cost of 49 ct. per square yard.

**Removing Block Pavement.**—In tearing up block pavement, any of the tools can be used, although a hand hammer is most useful when it comes to toothing out the edges of the section removed or cleaning used blocks of the adhering binder. With the introduction of air hammers a marked reduction in the breakage of blocks is to be noted. In one city where air tools are used it was found that a five-man gang using two hammers removed and cleaned 2,000 paving bricks in an 8-hour day—as compared with 1,000 brick for 10 men working by hand.

# Hauling 10-Ton Dinky on Trailer

Transportation difficulties due to the scarcity of freight cars, embargoes, etc., have been overcome in large measure by the Commissioners of Wayne County, Michigan, by the use of motor trucks and trailers. On many of the construction operations of the Commissioners it is necessary to convey materials and equipment to remote portions of the county. The accompanying illustration shows a 10-ton industrial locomotive being hauled on a Fruehauf semi-trailer by a 4-ton truck.



Truck and Trailer Transporter, 10-Ton Industrial Locomotive.

# Machinery and Labor Saving Devices on Connecticut Road Work

Connecticut, like other states, is faced at the present time with the necessity of maintaining its roads under extremely adverse conditions. On the one hand, there is a concentrated truck and motor vehicle traffic unparalleled in the history of highway maintenance in this or any other country. On the other hand, there is a shortage of labor and the difficulty of securing materials for maintenance purposes.

The first requisite to meet this situation, states Mr. C. J. Burnett, State Highway Commissioner, in July Public Roads, is additional attention on the part of the supervising agents; second, the utilization of machinery and labor-saving devices to a greater extent than in the past; and third, the securing of substitutes for material formerly used but not at present available, meaning, in case three, that local available materials must be used even though less adapted to requirements.

In a broad way, an attempt has been made first to increase the effort of the supervising agents by an appeal to their patriotism by a suggestion of necessity of work at high pressure to maintain a standard of excellence which has always been a matter of pride, and also to increase wages so as to make it more attractive for the men than in the past.

In connection with labor saving by the use of machinery, the motor truck has been utilized to a great extent in delivering material, spreading sand, gravel, and oil, and transporting gangs of men from one point to another at high speed. Advantage has been taken of mechanical loaders for gravel and sand, doing away with hand shoveling so far as is possible. Mechanical spreaders for sand and gravel to cover oil or other bituminous material have been utilized where possible. In fact, wherever it is feasible to substitute any machine, in such a manner as to save labor, it has been done even at a money loss. The department has also purchased a great amount of equipment so that local material can be quickly utilized. Such equipment consists of stone crushers, gravel screens, and machinery of a like nature.

# Who Shall Pay For Paving?*

By ELLIS R. DUTTON,

Assistant City Engineer, Minneapolis, Minn.

Who shall put the pay in paving? Those who receive the benefits. The question and answer is stated in the shortest, most logical and equitable manner. There is no question but that the improvement of a street or road is a benefit, else such improvements would not be made. Streets and roads are made for the accommodation of the general public and abutting lands to facilitate communication among peoples. This is the basic idea that the use of the roads and streets should be free and that the public as a whole should pay for the improvement of such thoroughfares. This may look good on the face of it, but let us see how it works out.

The road and street that is given for the free use of the public is in the condition as originally left by nature, and maybe it can be used, but generally it cannot be used to any advantage by the public, therefore the abutting lands cannot be utilized because of insufficient approach. In such a case the land is of little value, but improve the street or road and the land immediately takes on an added value by reason of such improvement, and such enhanced value is attributed directly to the improvement. In other words, the improvement is a decided benefit to such land. This enhancing in value of abutting property can and is seen in every city, and in every case where streets or roads are paved, and generally the increased value of the property is more than the cost of the improvement. Shouldn't these benefited lands pay for the paving?

There are also other lands not abutting on the street or road, but lying a little removed, say, in a city a block or so away. This property is also benefited to some extent, and should also contribute something toward the improvement. Perhaps in the case of this original improvement the general public might be considered benefited to some extent so that the payment for the original pavement would be made by these three classes, the larger of which is naturally the abutting land, and in much lesser proportion the contiguous land and the general public. In a great many places the whole cost is paid by the abutting property, and in others the general public pays for the street intersections, etc., in paying their part of the total frontages. In no city has it been successful to compel the general public to pay a very large part of the expense, as they will not stand for it, and therefore no work will be done.

For the purpose of financing the work and making the annual payments against the abutting property reasonable, the governing body should provide the funds as a loan, and make the time of yearly pavements extend over a term of years, say, from 5 to 20 years. After this original pavement is paid for, the abutting property should not be called on to pay for another pavement, as the road when it is completed is turned over to the operating department, so to speak, similar to railroad management.

While we are speaking of railroads, did you ever notice the similarity between roads and railroads? The construction is done by bonds and stocks in railroads, and by bonds and abutting street holders in roads. After construction, it is turned over to the operating department, which is the management in railroads, and expenses for maintenance, betterments and operation is paid by the traffic rates, and in the case of roads such maintenance, repairs and renewals should be paid by the users of the road, in the shape of license or wheel tax, proportioned to use. Another striking similarity is also shown in the increased loads, trains and engines in the case of railroads, and necessitating the almost whole reconstruction of the roadways, bridges, etc., to permit of such increases. So, in the case of the improved roads, it has increased the loads, and by the development of the auto trucks, it has necessitated the reconstruction of many roads and the building of better and more substantial road surfaces. In the case of the railroads, the users pay for these improvements, and why not so on our roads? It surely would be unfair to the abutting property owner to be obliged to pay for the repairs of his road which were made necessary by reason of the use of the road by persons that did not contribute to its original cost. Make the persons benefited pay for the cost of what they use. Is it fair for me to pay for a pavement to be used by him for his own personal benefit?

Another feature of the present-day use of roads is the general tendency to increasing the loads enormously without any regard or reference to the ability of the pavement to hold up under these loads. There are millions of yards of improved streets and roads in the county costing millions and millions of dollars which are being destroyed by ruthless overloading, and all of this has been paid for, not by the users or abusers, but by the property owners who receive almost no benefit by this abuse. Who shall pay for this destruction and reconstruction? Surely the users, but before total destruction, regulations should be made by the authorities as to allowed loading so as to prevent the roads' destruction, and if heavier road surfaces are necessary, to provide funds and methods for such heavier roads. The government and public are beginning to awaken to this fact, and are asking why should we provide a smooth and economical roadway without cost to private parties to use for their personal benefit.

Some of the license laws of our state are a farce when they license a light passenger car or a heavy 6-ton truck for 3 years for $5. Make the tax or license commensurate with the use and destruction of the road surface.

There is another item of destruction to road surfaces, and that is climatic conditions, and perhaps the general public might be entitled to pay for such deterioration, but it would be small compared to the use. Investigation and statistics should be made and collected to provide some basis for these license fees, and it should be done quickly or there will be no pavement left to use. Make the persons benefitd pay for the paving.

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*Paper presented at the recent convention of the American Society of Municipal Improvements.

# Concrete Road Practice of Wayne County, Mich.

Recent changes in the concrete road practice of Wayne County, Michigan, were described by Mr. Edward N. Hines, Chairman County Road Commission, in an address last September before the Michigan State Road Association. The changes made during the past year include increasing the thickness and width of the pavement and the adoption of 2-course construction.

The pavement thickness has been increased from an average depth of 7⅛ in. to 8¼ in. The present standard paved width is 18 ft., but the Commissioners are advocating the adoption of a 24-ft. concrete road which will be 32 ft. over all for roads built 10 miles out from the limits of cities. One 24-ft. wide road already has been built.

Owing to the congestion of motor truck and trailer traffic the Commission has found it advisable on Sundays and holidays to make the Jefferson and Mack highways one way roads for 12 miles out from the center of Detroit and through a number of small villages. Under this plan the traffic goes out by the Jefferson Road and crosses to the Mack Road for the return trip.

The county recently changed its specifications to 2-course construction, substituting crushed Wisconsin granite or trap rock for pebbles in the wearing course. Mr. Hines states that the new construction, despite the greater cost, is believed to be justified by the quality of the finished job. Fewer cracks develop in the roads built with crushed stone in the top course than in those built from pebbles. In this construction the wearing surface is laid when the base is still wet, and it is compacted and becomes an integral part.

Changes also have been made in the use of expansion joints. These are still placed at 25-ft. intervals, but the thickness of the asphalt composition joint filler has been increased from ⅜ to ½ in., and the filler is placed just below the finished roadway, the concrete being carried over it with the strikeboard. Steel armored joints have been discontinued, owing to the scarcity and high price of steel and the difficulty in getting absolutely even joints. Excellent results have been obtained with submerged joints in eliminating irregularities, and when the film of concrete which covers them finally breaks, they can be maintained with Tarvia and coarse sand. The Commissioners do not consider the entire elimination of expansion joints good practice; instead they have increased the joint ⅛ in. in width.

A minimum of 100-ft. radius for curves has been established, and, where necessary, extra right-of-way is acquired to obtain this radius. The policy of super-elevating all curves of 700-ft. radius or less has been established. All important intersecting roads are being marked with reinforced concrete signposts, 10 ft. high.

Snow removal is handled by the three superintendents who have charge of road construction in the summer. They are furnished with snow plows, scrapers, graders and shovels. Each superintendent is required to inspect his road and to have lists of men and team owners who will turn out for road cleaning. When a big snowstorm comes he gets at work in the shortest possible time.

## Curing Concrete Roads by Covering with Road Oil and ¼ in Stone

A method of curing concrete roads that does away with the dirt covering and sprinkling is employed by the Commissioners of Roads of Fulton County, Georgia. The plan was described by Mr. Wm. A. Hansell, Jr., County Superintendent of Public Works, at the recent convention of the American Society of Municipal Improvements.

After the concrete is sufficiently set to allow the work to be done, the laitance is swept off, using metal push brooms or other approved method, and the surface covered with bitumen of approved quality of viscoscity similar to road oil now used on Fulton County highways. It is then covered with sufficient ¼-in. stone to absorb any excess bitumen. The road is blocked from all traffic for 14 days before being thrown open to the public.

By this method of curing, stated Mr. Hansell, no sprinkling is necessary, no dirt is put on top to be taken off later, the traffic is admitted earlier, and the pavement is left of the same appearance as bituminous concrete. It is possible to admit traffic sooner because the bitumen and chats form a carpet which prevents the steel tire traffic cutting into the new concrete.

The experience in Fulton County has shown that from 4 to 5 sq. yd. of concrete may be covered with 1 gal. of bitumen. The aim is merely to seal up the top of the concrete, thus preventing the escape of any moisture from the material. This plan has been tried with the laitance left on the surface, but it was found that the difference in the adherence of the bitumen to the surface of the concrete was considerable, though the desired insulation from evaporation was equally good and the amount of bitumen required was reduced, due to the smoothness of the laitance and a corresponding reduction in thickness of bitumen left of the surface. In either case the insulation from evaporation is accomplished and the selection of the adoption becomes one of the cost of labor as compared with the good appearance of the road for a slightly increased length of time.

The Fulton County Commissioners used tar and asphalt for this covering and find tar gives better adherence, slightly more spread, but considerable more original cost. They are now using Mexican oil about 80 per cent asphalt at 100 penetration, the same material as is used for their road oil work.

**Survey Parties Needed by Construction Division of Army.** —The Construction Division of the Army has urgent need of 50 chiefs of survey party at $2,700 to $3,000 a year; 50 transitmen at $2,400 a year; 25 levelmen at $2,100 a year; 125 rodmen at $1,800 a year; 150 chainmen at $1,800 a year, and 50 topographic draftsmen at $2,100 a year. These positions are open to men only, except the drafting positions, which are open to both men and women. All of the positions are in the civil, not the military, service. Persons interested should apply to the U. S. Civil Service Commission, Washington, D. C., or to local civil service boards in the larger cities.

## Direct Loading of Aggregates Reduces Cost of Concrete Road Construction

An excellent system for the direct loading of aggregates was employed in the construction of a 10-mile section of the Coleman Du Pont concrete road in Sussex County, Delaware. The roadway is 14 ft. wide, 7 in. deep in the center, and 5 in. on the sides. The concrete was mixed in the proportions of 1 part cement to 2 parts of fine aggregate and 4 parts of coarse aggregate.

The only ingredients obtained locally for the construction of the road was water, which was obtained from wells driven about a mile apart alongside the road and was connected with 2-in. pipe lines with taps at intervals of approximately 150 ft. In some instances a small elevated storage tank was used, but where there was a sufficient supply of water this was not necessary.

On account of the lack of suitable materials in the nearby vicinity, it was necessary that all materials be delivered by railroad. The aggregate was loaded directly from freight cars into box containers, in correct proportions, transported to the concrete mixer and dumped directly into the skip. For emergencies, stock piles of sand and stone were maintained at the freight station, but these were seldom used.

The containers which held sufficient aggregate for a 3-bag batch, were transported to the construction by means of an industrial railway. Two containers were placed on each car and a train load of 15 cars hauled to the mixer. Containers were lifted from the cars by means of a derrick attached to the concrete mixer. Three men were required to dump the container into the skip and one man was necessary on the derrick to lift the containers from the truck. After the container was lifted approximately 4 in. it would clear the body of the car.

The transporting of materials was carried on by three trains handled by an industrial engine. While one train was being loaded at the freight station, the second train was being hauled to the concrete mixer, and the third train was being unloaded at the concrete mixer. This method worked out very satisfactorily up to a 4-mile maximum haul, and with proper equipment there should be no limit for the satisfactory working of this method. The cars holding the containers were moved at the concrete mixer by hand or by mule.

It was necessary to have a siding for storing the empty cars near the mixer in order to allow the trains to pass. This siding was moved each day with very little trouble and at small expense.

The specifications required that all concrete should be mixed 1½ minutes and there was no delay on account of the direct-loading method. Under favorable conditions, approximately 600 ft. of 14-ft. pavement was completed in one day, all the concrete having been mixed 1½ minutes.

This direct loading method, states Mr. Charles M. Upham, Chief Engineer Delaware State Highway Department, in an article in Public Roads, not only produced more uniform and better concrete, but it increased the output of the plant and at the same time reduced the cost of construction.

## Repairing Ruts in Macadam Roads

Many of the macadam roads in Prince Edward County, Ontario, constructed of a rather soft limestone, develop two wheel ruts, the road surface otherwise being in good shape. A road in this condition is repaired in the following manner: The rut is first well wetted with water and crusher run of stone is added to it. The stone is then rolled tightly into the ruts and water is sprayed over the whole road. The puddle of limestone dust and water which is thus formed is brushed into the ruts, making a kind of mortar to hold the new stone. The road is allowed to dry out a little and is then rolled. If the work is properly executed, good results are obtained.

# The Engineer's Creed*

**Obligations of the Engineer.** The engineer has obligations a few of which may be adverted to

In accepting an engagement in any field of service in which he has not already proven his attainments to be equal to the task, he should be frank with his client and state just what his previous experience has been and give the reasons which, in his judgment, justify his undertaking the contemplated work. Many a man has had responsibilities thrust upon him by clients who, though fully aware of his lack of previous experience in the field which they wished him to enter, recognized in him resourcefulness, good judgment, industry, and frank honesty, which they believed fitted him to carry the new responsibility to a successful issue; and not often has he failed.

The engineer, in responsible charge of construction work which is being done by a contractor, individual or firm, at once exercises two functions, one requiring engineering knowledge, skill and experience; the other judicial fitness. He becomes the arbiter between the principal, man, firm, or corporation for whom the work is being done and whose money is paying for it, and the contractor who is doing the work. He must be a just judge, executing righteous judgment between the parties to the contract, without fear or favor. The fact that his client, the principal or first party to the contract, pays him must not have the value of a pennyweight in tipping the scale in favor of the source of his income. The engineer owes his client an allegiance demanding intelligent, conscientious, and diligent service. That he owes, but his debt demands for its liquidation no act, no word which would compromise his integrity or offend his sense of justice and right.

The engineer's obligation to serve is not limited to the duties for which he is paid; he owes it to his equals in service, to his subordinates, and to the public at large. His equals are his brothers with whom he should share his knowledge and experience, should they seek it. His subordinates should find in him the help of good example; the friend with whom they may take counsel, and the mentor who will impart of his knowledge of life, of men, and things, to aid them in shaping their conduct and their purpose.

To the public at large, he owes good citizenship. With every other citizen he shares responsibilities for government, civic, state and national, and his efforts should be to make government good. He cannot hold himself aloof from those activities which our form of government imposes upon those who live under it, and escape responsibility for its shortcomings and its failures. If an unworthy man represents him in any governing body, he shares that unworthiness unless he exercised the right and duty of good citizenship and tried to put a good man into the office that the weak or bad man holds. "They also serve who only stand and wait" may be true of those who through misfortune are cut off from life's activities, but the saying does not apply to any live engineer. "He must be up and doing." He must keep his mental equipment as fit for service as the soldier keeps his arms, and the guiding motives of his life true, lest they fail him when the hour of trial comes.

Moreover, an engineer owes a professional obligation to the public by reason of his special training along technical lines. Therefore, he should use his knowledge and experiance to promote the general welfare by every means in his power. He stands upon the watch tower of progress to warn against danger and to show the way to better methods in dealing with problems of engineering. He should stand against the individual or group of individuals who try to exploit, for their own profit or advantage, forces of nature which belong to the nation, the state, or the municipality, without making a just return therefor to the rightful owners of the potentiality.

Wherefore should an organization of honorable men present a code of ethics when each carries in his own mind and heart rules of right living and honorable action?

It is "Lest we forget."

The law-abiding are not conscious of the restraints of the law, but the lawless are made to feel its power. A code of ethics accepted by the great body of professional men is the declaration of their faith, the chart by which they direct their course in the voyage of life. To this chart one who is in doubt may turn for suggestion as to the right course in any time of perplexity and by the principles laid down in this chart transgressors will be judged and disciplined by their fellows:

**The Code of Ethics.**—Any code of ethics must be predicated upon the basic principles of truth and honesty. "Whatsoever things are true, whatsoever things are honest," are the things for which engineers must contend.

An engineer may not "go beyond and defraud his brother" by any underhanded act or method. He may not do or say anything which will injure his brother's reputation or his business for the purpose of securing his own advancement or profit. This admonition carries with it no obligation to refrain from telling known and absolute truth about an unworthy brother, as a protection to others, but the truth so told must be such as can be substantiated, and he who tells it must have the courage which will not shrink from the consequence of his telling.

The engineer owes his client allegiance demanding his most conscientious service. But conscientious service to the cient must never entail a surrender of personal convictions of truth and right.

An engineer who receives compensation from an employer may not receive gift, commission, or remuneration of any kind from a third party with whom he does business for that employer.

An engineer seeking to build up his business may not resort to self-laudation in advertising. He may state briefly the lines of work in which he has had experience and enumerate responsible positions which he has held and give his references.

An engineer who employs others, either in his own service or in that of the client who employs him, should recognize in his relationship to them an obligation of exemplary conduct, of helpfulness and personal interest in those with whom he is thus brought in contact, and he should discharge such obligation tactfully and kindly.

The honor of the profession should be dear to every engineer and he should remember that his own character and conduct reflect honor, or the reverse, upon the profession.

If, then, he so lives that his own honor shall never be smirched by his own act or omission, he will thus maintain the honor of the organization to which he belongs.

## Highway Cost Keeping

The U. S. Office of Public Roads and Rural Engineering, in a recent extensive investigation of highway management both by the state highway departments and by a large number of individual counties and townships, found few examples of practical and efficient cost keeping in operation. Such systems as were discovered were confined largely to the state highway departments, and only in rare instances were cost keeping systems found in counties and townships. This condition is due largely to the notable scarcity of information available on the subject of highway cost keeping, and also to a lack of appreciation by public officials of the usefulness of highway cost data. In order to supply information on the subject the U. S. Office of Public Roads has just issued Bulletin No. 660. This publication, prepared by James J. Tobin and A. R. Losh, U. S. Engineer Economics, and reviewed by Halbert P. Gillette, discusses the principles that govern cost keeping and gives a practicable application of these principles to highway work. The subjects treated include the following:

Part 1. Cost of Keeping in General; Fundamentals of Cost Keeping; Cost Elements; Fixed Charges; Highway Cost Analysis; Units of Measurement.

Part II. Cost Keeping for Highway Work; Essentials of a Cost System; Classification of Expenditures; Operation Code; Method of Obtaining Class and Operation Number from Code; Method of Obtaining Class and Operation Number from Code; Use of Code in Operations; Details of Cost Accounts and Necessary Codes; Recording Forms; Immediate Use of Cost Data; Final Disposition of Cost Data; Definitions of Operation Terms.

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*From the report of a [illegible] resolution adopted at the Third Annual [illegible] Association of Engineers held on May 13, 1918, [illegible]

Copies of the bulletin can be obtained from the U. S. Office of Public Roads and Rural Engineering, Washington, D. C.

## Cost of Painting Steel Highway Bridges

The cost of painting steel bridges in Keokuk County, Iowa, was greater by day labor than by contract, according to figures published in the September-October Service Bulletion of the Iowa Highway Commission.

Of three bridges painted by day labor the cost per foot averaged $.68, $1.53 and $1.07. On eight jobs painted by contract the range per foot was $.55 to $.85. A tabulation of the cost data prepared by District Engineer J. S. Morrison is as follows:

### Day Labor Work.

One 40x14 ft. steel truss on concrete abutments-wood joists.

| | |
|---|---|
| Labor—One man at 35 ct. and one at 40 ct. per hour, working 21 hours | $ 15.75 |
| Paint—1¾ gal. sublimed white at $2.25 | 3.94 |
| 2¾ gal. sublimed blue at $2.15 | 5.91 |
| Brushes | 1.60 |
| Total cost | $ 27.20 |
| Cost per foot | 0.68 |

One 110x16 ft. and 18 ft. high light steel truss-wood joists.

| | |
|---|---|
| Labor—One man at 35 ct. and one at 40 ct. per hour | $ 84.75 |
| Paint—12 gal. at $2.15 | 25.80 |
| 5 gal. white at $2.25 | 11.25 |
| ½ gal. L. oil | 0.90 |
| Brushes | 4.18 |
| Total cost | $126.88 |
| Cost per foot | 1.53 |

One 110x14 ft. and 16 ft. high light steel truss-wood joists.

| | |
|---|---|
| Labor—One man at 35 ct. and one at 40 ct. per hour | $ 72.75 |
| Paint—13 gal. blue at $2.15 | 27.95 |
| 5 gal. white at $2.25 | 11.25 |
| ¾ gal. L. oil at $1.80 | 1.35 |
| Brushes | 4.00 |
| Total cost | $117.30 |
| Cost per foot | 1.07 |

### Contract Work.

On the following bridges the price is made per lineal foot of truss measured center to center of bearings. The price includes the painting of all wooden guard rails on approaches, the contractors to furnish their own transportation for themselves, the tools and materials; the county to furnish the wire cleaning brushes, paint and the paint brushes.

All bridges to be cleaned and painted with two coats, the end posts of all trusses and guards to be trimmed in white, all work to be satisfactory to the County Engineer. All bridges have wood floor and wood joists and it is under stood that all cylinder piers are to be painted, where they are used in the structure, and included in the price per lineal foot of span painted.

One 170x14 ft. span 25 ft. with a 40x14 ft. pony truss at each end and resting on cylinder piers, erected in 1905, making 250 ft. over all. This bridge had one coat of paint at the time of erection. It was very badly rusted.

| | |
|---|---|
| Total cost | $212.50 |
| Cost per foot | 0.85 |

One 160x16 ft. span 25 ft. high and one 40x16 ft. pony truss on approach, all on cylinder piers, 200 ft. over all, not badly rusted at time of painting.

| | |
|---|---|
| Total cost | $170.00 |
| Cost per foot | 0.85 |

One 140x16 ft. truss resting on cylinder piers, old paint scaly and badly rusted.

| | |
|---|---|
| Cost per foot | $ 0.70 |

One 190x16 ft. King truss 25 ft. high, moderately rusted, 140 ft. of wood guard rail approach.

| | |
|---|---|
| Cost per foot | $ 0.85 |

One 190x14 ft. truss 25 ft. high on cylinder piers, badly rusted.

| | |
|---|---|
| Cost per foot | $ 0.80 |
| One 150x14 ft. bow string truss at 55 ct. per foot | $ 0.55 |

One 105x14 ft. and one 75x14 ft box string truss were given two coats of paint with cost as follows:

| | |
|---|---|
| Labor at contract price, 55 ct | $ 99.00 |
| Paint, 17½ gal. at $2.15 | 37.63 |
| Brushes | 3.90 |
| Total cost | $140.53 |
| Cost per foot | 0.78 |

One 40x14 ft. low truss span cost as follows:

| | |
|---|---|
| Labor at contract price, 40 ct. and 55 ct. per hour | $22.00 |
| Paint, ½ gal. white | 1.12 |
| Paint, 2 gal. blue | 4.30 |
| Total cost | $27.42 |
| Cost per foot | 0.68½ |

## Personals

**W. H. Steiner**, city engineer of Marshalltown, Ia., has been commissioned first lieutenant of engineers.

**P. C. Harris**, assistant state road engineer of Utah, has been given a commission as lieutenant in an engineers' regiment.

**R. E. Pierce**, an engineer of the State Highway Commission of California, has been commissioned first lieutenant in the 403rd Engineers.

**Lieut. Frank D. Gore**, formerly county engineer of Kitsap County, Washington, is now instructor in cross-country flying at Carruthers Field, Texas.

**Carl Smith** has resigned as engineer of the County Road Commission of Kewanee County, Michigan, to take a field position with the Ingersoll-Rand Co.

**Charles Folsom** has resigned as road engineer of Christian County, Kentucky, and is now employed at Florence, Ala., on the construction of a government dam.

**Clarence S. Jarvis**, for the past year office engineer of the State Road Commission of Utah, and previous to that time connected with several of the largest irrigation projects in Utah, has been commissioned a captain in the 403rd Engineers.

**P. F. Patten**, formerly highway engineer for Greenville and Henderson Counties, South Carolina, has been appointed highway engineer of Spartanburg County, succeeding Reid Tull, who died three weeks ago.

## Obituaries

**Joseph Bartholme**, civil engineer of Cleveland, O., died Oct. 31, aged 25.

**R. N. Thompson**, a contractor of Waco, Tex., died Oct. 18, aged 50.

**C. Ballard Taylor**, formerly deputy city engineer of Utica, N. Y., died Oct. 23.

**Tom C. Tarver, Jr.**, formerly city engineer of Houston, Tex., died Oct. 23, aged 34.

**Patrick Cullen**, Commissioner of Public Works of Oswego, N. Y., died Oct. 30, aged 70.

**William N. Ball**, a contractor of Davenport, Ia., died Oct. 22 at Camp McArthur, Tex.

**Thomas F. Cook**, for the past eight years assistant superintendent of streets of Brookline, Mass., died Oct. 6.

**Frederick D. Dollenberg**, county surveyor of Baltimore County, Maryland, died Oct. 25 at his home in Towson, Md.

**Edwin J. Potter**, construction engineer for the B. F. Smith Construction Co. of Providence, R. I., died Oct. 13 at his home in Bridgeton, R. I.

**Ford C. Bowman**, manager of the waterproofing department of the Philip Carey Co., Cincinnati, O., died Oct. 26 of influenza-pneumonia. Mr. Bowman was a graduate of Purdue University and entered the employment of the Carey Co. about eight years ago.

**Lieut. E. Claire Tovey** died Oct. 17 at Williamsburg, Va., aged 28. He formerly was a member of the engineering firm of Humphreys & Tovey, Pine Bluff, Ark. He received a commission as lieutenant in the coast artillery at San Francisco and was later transferred to Virginia and had been ordered overseas when he became ill.

**Clarence Coleman**, U. S. District Engineer at Duluth, Minn., died Oct. 23 at his home in that city. Previous to his associations with the government engineering service he was connected with several of the middle and southwestern railroads, among them being the Houston & Texas R. R., the Housatonia Line and the Santa Fe Southern.

**William A. Lydon**, president of the Great Lakes Dredge & Dock Co., Chicago, died Oct. 28 at his home in Chicago after an illness of several months. Mr. Lydon was a graduate of the civil engineering department of Lehigh University. He served as civil engineer for the city of Chicago from 1887 to 1890. In 1891 he became a member of the firm of Lydon & Drews Company, river and harbor contractors. In 1904 he organized and became president of that company's successor, the Great Lakes Dredge & Dock Co.

## Industrial Notes

**The Lakewood Engineering Co.** of Cleveland announces the opening of its own offices in New York City in the Trinity Bldg., 111 Broadway.

**The Watsontown Brick Co.**, Watsontown, Pa., J. C. Fowler, secretary and manager, has become a member of the family of licensees of The Dunn Wire-Cut Lug Brick Co. of Conneaut, O., and will engage in the manufacture of wire-cut lug paving brick.

**Clifford F. Messinger**, manager of the concrete mixer department and advertising manager of the Chain Belt Co., Milwaukee, Wis., has enlisted in the Gas and Flame Division, Chemical Warfare Service, of the United States Army. He has been commissioned first lieutenant and is stationed at Camp Kendrick, Lakehurst, N. J.

**The Chicago Pneumatic Tool Co.** announces the appointment of A. M. Brown as district manager of sales, 1740 Market St., Philadelphia, succeeding G. A. Barden, who remains in Philadelphia as sales representative for the company. For some time past Mr. Brown has been located in the New York offices of the company as assistant manager, compressor sales division.

**The Barber-Greene Co.**, Aurora, Ill., announces the strengthening of its organization as follows: F. E. Smith, chief engineer, formerly of the engineering department of the Stephens-Adamson Mfg. Co., of the Granby Mining & Smelting Co., and the American Zinc & Chemical Co. Geo. C. Sanford, superintendent, formerly of the Elevator Supplies Co. and of the Otis Elevator Co.

**The Walter A. Zelnicker Supply Co.**, St. Louis, Mo., announces the appointment of R. H. Wilson as assistant to the president, with office at St. Louis. Mr. Wilson has been with the Zelnicker Co. for years, his last position being as Houston representative. He is succeeded there by E. O. Griffin, well known in southwestern railroad circles for the past 20 years as storekeeper and assistant general manager of the International & Great Northern, and more recently as assistant to the president of the St. Louis Southwestern R. R. in charge of purchases.

*Waterworks and Hydraulics Monthly Issue*

**ENGINEERING *AND* CONTRACTING**

**Published by Engineering & Contracting Publishing Co., 608 South Dearborn St., Chicago.**

HALBERT P. GILLETTE, *President and Editor.* LEWIS S. LOUER, *Vice President and General Manager*

New York Office: 50 Church St., RICHARD E. BROWN, *Eastern Manager.*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering field.

**Roads and Streets—1st Wednesday**
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies

**Waterworks and Hydraulics—2nd Wednesday**
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power

**Railways and Govt. Works—3rd Wednesday**
(a) Excavation and Dredging (c) Harbors and Docks
(b) Rivers and Canals (d) Railway Construction

**Buildings and Structures—4th Wednesday**
(a) Buildings (c) Ship Construction
(b) Bridges (d) Miscellaneous Structures

Volume L. CHICAGO, ILL., NOVEMBER 13, 1918. Number 20.

## Peace

The game is finished. The gambler for world dominion has made his last play and has lost. The horrible nightmare that has held civilization in its thrall is over. Peace has come. For over 4 years the earth has been soaked with blood. Millions of men—the pick of their races—have perished. Whole countries have been overrun, nations have been crushed and dynasties overthrown. Great cities have been destroyed and fertile fields turned into barren wastes. Famine and want have stalked through the land. Since that summer day in 1914 when a nation of egotists, lusting for conquest, hurled itself on an unsuspecting and unprepared world, terror and suffering and sorrow have been the part of five-sixths of the human race. But it is over now. Peace has come. The great war is finished.

## Compulsory Metering of Water as a Means of Saving Coal

It has been said that the National Fuel Administration may order the universal metering of water wherever pumping is involved, in order to eliminate the waste of coal that invariably occurs where meters are not extensively used. Engineering and Contracting was the first, we believe, to suggest such a plan; but the imminent ending of the war seems likely to lead to nothing more than talk at this time. Nevertheless the nation has learned a lesson in fuel economy that will make it easier hereafter to impress the public with the desirability of eliminating all unnecessary wastes of fuel.

About 60 per cent of our population is supplied with water from water works plants, but as yet barely one-quarter of these consumers are metered. Judging from the results achieved in cities that are completely metered, there is a waste of water amounting to 25 to 50 per cent of the total in cities where there are few or no meters. In many instances the waste considerably exceeds half the total water supplied. The mere fact that the war will soon be over and that fuel will again be abundant, should of course be no excuse for continuing this great waste of coal. Our coal deposits will be rapidly enough depleted at best, without needlessly hastening their exhaustion. But, aside from all considerations of a political economic nature, a continuance of coal waste is inexcusable, for the coal saved will pay handsome dividends on the capital invested in meters.

The metering of all consumers of city water is a matter of economic public policy in which all water works managers and all civil engineers should be sufficiently concerned to take the initiative.

## Some Remarks Suggested by Advertisements of a Certain Company

"Advertising is nothing more, and nothing less, than a speedier, more effective, more economical way of winning the market's confidence for products of superior merit."

This is the opening sentence of a unique "advertising bulletin" issued by the Chain Belt Co. of Milwaukee. We speak of it as unique because it discusses this company's advertising campaign for the year 1918, and illustrates the discussion with a large number of full page advertisements. The reader therefore feels a good deal as does a man who is taken behind the scenes by the author of a play. Accustomed previously to the point of view of one of the audience, he is now given the viewpoint of the writer and of the producer of the drama.

The reader of this interesting "advertising bulletin" is told some of the fundamental principles of effective advertising. Then he is asked to consider how these principles have been applied in the advertisements of its products. Twenty-one full page "ads," taken from the Saturday Evening Post, Engineering News-Record, and Engineering and Contracting, are followed by 21 full-page and 8 half-page "ads" from nine other periodicals.

As this editorial is not intended as a review of this "bulletin," but merely as a comment upon an unusual form of advertising, there is no occasion to speak of the character of the advertisements in it. Nevertheless, we may say that they are admirable examples of modern periodical advertising. Most of the "ads" are of the educational type. Many of them have striking captions. "Spring Points Her Finger at Your Intake" is the sort of heading that arrests the attention of a hydraulic engineer at once. It makes him think of the spring flood debris that will clog his screens, and it raises in his mind a question as to how Rex Traveling Water Screens may relieve him of his trouble. Such a caption shows that its author has studied practical psychology as well as the use of language. And the thought occurred to the editor—perhaps because he was himself at one time a writer of advertisements—that the author of this "advertising bulletin" would do well in future editions to do what Edgar Allan Poe once did. Poe published an essay describing exactly how he wrote "The Raven," the theory upon which he selected the subject and the title, the method of beginning with the climax clearly in mind, the selection of the type of rhythm to produce the desired effect of profound melancholy, and the various other artistic mechanisms used in that celebrated poem.

Those who have not studied the art and science of advertising—and few have—are prone to regard an advertisement purely as a sort of business card. That an advertisement can be as instructive as an engineering article, or as interesting as a bit of romance, has been proved again and again. But the reading public has yet to be taught that the authors of such advertisements employ as much science and art as do the authors of scientific and general articles.

The late Elbert Hubbard, editor of "The Philistine" and of "The Fra," did a great deal toward showing people that an advertisement could be made intensely interesting—as interesting as the piquant pages of his own magazines. His "ads," like his "eds," were literary jewels.

Each year sees a marked improvement over the preceding year in the general character of the advertising pages of magazines, both as to the matter in them and as to the way of presenting it. Hence the growing effectiveness of advertising. Hence the growing managerial efficiency of men who have acquired the habit of reading advertisements. It is no mere coincidence that America has: (1) The most successful manufacturers and producers, (2) The best trade and general magazines, and (3) The most extensively distributed and best written advertisements, in the world.

## How Long Will It Take to Demobilize Our Army?

Several very foolish utterances have recently been made by Government officials to the effect that it would be several years before our great army is demobilized. The ridiculous assertion was made by one official that it would take our soldiers two years to remove the barbed wire that the Germans have left in France and Belgium. Scarcely less absurd is the picture painted by another official of most of our soldiers remaining two years in France because of lack of transports. Doubtless he reasoned that because we had not been able to send them to Europe faster than at the rate of a quarter of a million a month, we shall be unable to bring them back at a faster rate.

Hurley has announced that there will be no change in our shipbuilding plan whatever the outcome of the war and whenever the end of it may come. Not only is this merely a personal opinion—for Congress will decide, and not Hurley—but it is the personal opinion of one who is seemingly more of a politician than statesman. Certainly no real political economist would propose so vast and wasteful a duplication of shipping tonnage as our war program has involved, unless war were to continue. Even were the purpose to secure our full share of the foreign trade through control of adequate shipping facilities, it would be feasible to accomplish the purpose in a more economic way.

A league of nations to preserve peace and to patrol the ocean is but one step removed from a similar league to promote international trade; and such a league could take no step better designed for the purpose than to control their shipping on the seven seas. The nations thus allied need not go so far as to own all the merchant marine. They need simply control the operation and the rates charged by all the vessels flying their flags. An International Commerce Commission would thus do for the allied nations precisely what our Interstate Commerce Commission does for our "federated states," ships and seas taking the place of cars and tracks.

Returning to the question of demobilization, it seems clear that when we cease sending munitions of war to France, we can, if we wish, bring back all our soldiers within six months or sooner. That we shall bring nearly all of them back as quickly as possible, seems likely. To hold them longer in France than is necessary would be an imposition upon them.

## What Engineering Societies Should Do to Assist in Providing Work for Soldiers and Others Who Will Soon Be Out of Work

An army of more than two million in Europe, another army of nearly two million soldiers in America, and an industrial army greater than both those combined, will soon be out of a job unless steps are quickly taken to provide them with peace work in place of war work. Engineers and contractors have played a great part in the game of war. They should now prepare to play an even greater part in peace.

Engineers and contractors, through their national and local societies, should now begin to shape public opinion as to the sorts of public works that should be built or improved and as to the immediate steps to be taken to hasten the preparation of surveys and plans. The public does not realize that wise expenditures can seldom be made unless preceded by careful engineering studies. Hence the urgent necessity of action on the part of engineering societies, with a view to showing county commissioners, city councils, state legislatures and Congress that not a day should be lost in surveying and planning public works.

Because taxes have risen enormously there will be some opposition to taxation and bond issues for extensive public works, but the opposition can and will be overcome. The great majority of the voters will not favor discharging our military and industrial armies without making adequate provision for their useful employment. And among the various kinds of useful employment that can be speedily provided, nothing surpasses in economic importance the building of irrigation works, the drainage of lands, the construction of highways, railways, sewers, water works, bridges, and all the wealth and health producing plants commonly known as civil engineering works.

Through organized effort engineers should be able to awaken the public as can no other class of men, but they should not confine their activities to their own societies. They should join with other organizations, such as chambers of commerce, labor unions, etc., to secure as wide and effective support as possible.

Where local engineering societies do not exist, engineers should organize themselves into committees on political economy. Such committees should be much more than mere debating societies. Their object should be twofold: First, to decide what new local public works will be of greatest value to the public. Second, to influence the public to accept the decisions of the engineers and to act promptly upon them.

In nearly every city there is to be found at least one engineer (and often many) who is a convincing and interesting public speaker. Let such men be selected to address city councils, chambers of commerce, etc. Let the substance of each address be typed and given to the daily papers. Let articles be written by engineers and submitted for publication in the dailies. Let clippings of editorials and other articles from the technical press be sent to the dailies, accompanied with letters from local engineers. In short, let every agency of publicity be adopted and systematically used, and it need not take long to secure the desired results, for the public is in a mood to act favorably if urged repeatedly and strongly to do so.

Now also is the time to effect revisions in ordinances and laws that restrict the development of public enterprises in an economic manner. Probably there is not a city, and certainly there is not a state, in which bad legislation does not stand in the way of the truly economic development and extension of public works. We have frequently commented upon such laws, and shall be glad to assist any engineering society by pointing out again many of the present legal obstructions to the economic expansion of public works.

# Wash the Streets to Remove the Germs

Although the managers of waterworks plants do not ordinarily have charge of street cleaning, it lies within their power to assist both directly and indirectly in securing cleaner streets. And by "cleaner streets" we do not mean streets free only of visible dirt, but streets free of the invisible microbes that ride upon the finest grains of dust. Water, the great cleanser, should be applied daily in large quantities to all business streets, and at frequent intervals to all paved residence streets. The germ-laden dust should be flushed into the sewers before it can spread pneumonia, tuberculosis, grippe or influenza, and other diseases of the nose, throat and lungs.

It devolves upon every conscientious man who knows the efficacy of water as a sanitary agent, to do his best to arouse the public and its representatives to the desirability of flushing all paved streets periodically. The superintendent of every waterworks is particularly one who should never rest until his city's streets are as clean as a hospital floor. While it is his duty to prevent the waste of water by meterage and otherwise, it is also his duty to encourage the consumption of more water for sanitary purposes and for garden irrigation. A low per capita consumption of water should not be his ultimate goal, but rather as high a per capita consumption as may be attained after eliminating all waste.

Read the following letter to the editor of the San Francisco Chronicle, bearing in mind that it is typical of the belief of most physicians that respiratory diseases are transmitted by the germs that motor cars and gusts of wind stir up from dirty streets:

> Editor The Chronicle—Sir: In the name of humanity now stricken and suffering, I desire to call attention to one of the causes that has to do with the spread of the influenza and the increase in the number of deaths due to this plague—I refer to the unwashed and filthy streets of San Francisco. As a medical man who has studied epidemics and their spread, I am certain that there would be perhaps 25 per cent fewer cases here if the streets were kept clean and free from dust and dirt, and if the law against spitting were even half-way enforced, which it is not. The people of this city have themselves to thank or blame for their present sufferings—or rather the officials whom they put in power. I have no interest in local politics, but for the sake of the life and health of the community, cannot something worth while be done to clean up the streets? They are in a dangerous condition of filth, a condition that would dangerously menace the health of the community, even if there were no epidemic.
>
> T. D. LEWISTON, M. D.
>
> San Francisco, October 31, 1918.

Dr. Lewiston states the case for clean streets mildly enough. It would be nearer the mark to say that three-fourths of all the respiratory disease germs reach the nose, throat and lungs from the street surfaces where they were deposited by diseased people.

## What Is An Engineer?

A new definition of the engineer has been written by A. H. Krom, Director of Engineering, United States Employment Service, Chicago. The definition comes as the result of the many queries that have originated through a confusion of engineering terms and standards now in general use. After serious study and consultation with authorities, Mr. Krom prepared the following definition:

"An engineer is one who economically directs man power and, by scientific design, utilizes the forces and materials of nature for the benefit of mankind."

In writing this definition, Mr. Krom hopes to offer a practical, workable statement that will be of real value to technical men. In view of the importance of the engineer in the present war, is is highly important that his status be properly defined.

**Oklahoma Municipal League Meets Nov. 29.**—The annual convention of the Oklahoma Municipal League will be held Nov. 29 and 30 at Oklahoma City. Mayor P. P. Duffy of El Reno, Okla., is President.

# "What Are You Going to Do About It" and Meter Matters

The Bureau of Municipal Research of Philadelphia, Pa., is doing excellent work in promoting efficient and scientific management of municipal business. One of its methods of educating the general public is the issuing each week of little bulletins. These publications are popular rather than technical in character and are designed particularly for calling the attention of the public to existing conditions that need remedying. Two recent bulletins of the Bureau of particular interest to water works officials bear the striking titles of "What Are You Going to Do About It?" and "Meter Matters—Meters Matter." These bulletins are reprinted below.

### What Are You Going to Do About It?

**Philadelphia's Big Sieve.**—We do not hear much about sieves these days. Flour is on its way to the Soissons front, instead of loafing around Friend Wife's kitchen, and sieves in general are crowding into the class of non-essentials.

But the Chief of the Water Bureau, looking over Philadelphia from the seventh floor of City Hall, tells us he sees a sieve with 2,000,000 holes.

He is talking about the water works. There are 2,000,000 openings fed by the Philadelphia water works—faucets, toilet fixtures, and other connections through which water is used—and wasted. Because a leak this (.) size may waste 2,000 bbl. a year!

Two million openings to the water works; and, by coincidence, approximately 2,000,000 people in Philadelphia—an opening for every man, woman and child in Philadelphia county, and a corresponding opportunity for every man, woman and child to save precious water.

**This Is No Forest of Arden.**—Water doesn't bubble out of the rocks any more. Not in cities. The water that flows under your prodigal twist of the spigot has to be pumped, filtered and stored. Every drop of it represents an item of coal cost, when every pound of coal is needed in ship's bunkers and home cellars; and an item of labor cost, when every ounce of man-power is needed in France or in essential activities at home. And city water differs from the spring on the old homestead in another particular: it is not inexhaustible. The number of gallons you can use a day is strictly limited by the number of gallons you can pump and filter. Philadelphia's 300,000,000-gal.-a-day water system is now compelled to furnish a 330,000,000-gal-a-day output, without any let-up. No chance for a main to rest or a pump or filter-section to be cut out of service for overhauling and repair.

**Coal for 2,500 Cellars.**—The Chief figures that 60,000,000 gal. of this daily consumption was wasted. Twenty-five thousand tons of coal a year, to pump wasted water! If the demand for water were normal, just the saving of wasted water might mean the gain of winter's coal for 2,500 homes. But the need is worse than that. Saving is imperative not merely that cellars may have coal, but that munition plants and war industries may have water that now they cannot get. Even with the water system carrying a constant 10 per cent overload, Philadelphia's essential war industries are clamoring for a supply of water 20 per cent larger than the utmost it is now possible to give them.

**Hooverize.**—It often happens, when things go wrong in a municipality, that the bulk of us have to sit back and fume in impotence. But not this time. We do not have to wait until the November elections. The Food Administration has taught us the tremendous potential of concerted small savings. Remember that the water works has one potential leak for each one of us. Your job is to plug yours up. It may mean a new washer. It may mean getting that "fine lawn" effect with a close-set lawn mower instead of a garden hose. If you are a landlord, it may mean an interview with the plumber, and the installation of patriotic plumbing fixtures—especially if you are one of the landlords who has "boosted" rents. Whatever it means, do it, and start doing it now.

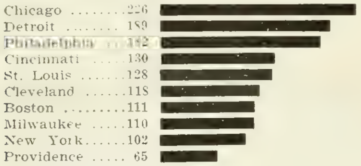
**The Biggest Hole Is at the Top.**—Sieves are like socks. The biggest hole is at the top. The fact that water conservation is an imperative, essential, root-hog-or-die necessity doesn't relieve City Hall of any responsibility. Appropriate legislation for compulsory universal metering ought to be enacted the first day Councils meet, and the work put under way just as rapidly as the Government war program will allow the city to get meters and men to install them. Water rebates should pass into history. The Water Bureau's last annual recommendations, and the proposal for express mains from Torresdale and Lardner's Point to Callowhill St., should be promoted from their resting-places in the Public Works offices, expanded, if need be, into a complete water works program that will take care of all our needs, and put relentlessly up to the public for action. And the unfilled need for wading-pools, that has resulted in the midsummer opening of fireplugs growing into a pernicious and deep-rooted habit, suggests work for the Board of Recreation that might enable it to get desirable headlines in the newspapers.

Unless these things are done, appeals for individual saving of water may do but little good. American civilians, like American soldiers, like to be led into action.

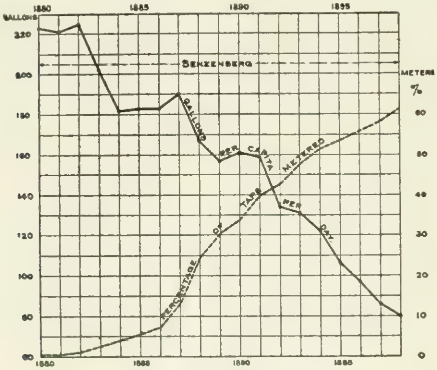
### Meter Matters—Meters Matter.

**One of the Big Wasters.**—Philadelphia is one of the worst of the American cities in her enormous wastage of drinking water as is evidenced by the table below. Contrast Philadelphia's 182 gal. with the 65 gal. used by Providence. Yet it cannot be claimed that Providence people suffer for lack of water. The most important reason for the difference is that Providence metered 65 per cent of her supply, while ours was only 8 per cent metered.

WATER CONSUMPTION IN AMERICAN CITIES IN 1916.
In gallons per capita per day.



**Meters Give Prompt Relief.**—While Philadelphia's use and waste of water has been steadily mounting skyward, from 72 daily gallons per capita in 1885 to the present 182 gal. per capita, other cities have been cutting down their waste. There are any number of striking examples of water saving due to the use of meters; for example, Cleveland, Petersburg, Providence and Oak Park. The effect of meters on water waste in Milwaukee is a good example. Notice that as the percentage of meters increased, the gallons per capita went down. Cause and effect could hardly be better illustrated.



Milwaukee's Experience with Meters.

**More Water, Not Less.**—While the use of meters cuts down the per capita use of water, the experience of other cities has been that people are not curtailed in their legitimate use of water, but have even more water for such use. Only about one-fifth of the people are big wasters. Metering would restrain this waste and thereby increase the quantity that would be available for families, for office buildings, and for factories. The objection that metering would reduce normal water use and so cause dirtiness and ill health, has been found false in other cities.

**The Old, Old Gags.**—The countless theoretical objections to meters that are advanced locally today are the same ones that were disposed of years ago in other cities. The best answer to such objections is that they are never heard in cities where meters are largely used. Meters are only opposed where they are unknown.

**Councils' Patriotic Duty.**—Let Councils not be led astray by the calamity howlers, but let them seek the well nigh universal opinion of other cities and of the engineering profession. A most cursory examination would convince them of their patriotic duty to legislate for universal compulsory metering. At the time of going to press (this bulletin was issued Sept. 26), it begins to look as though the Government might interfere just as they did in the vice situation, and order meters installed as a fuel saving necessity. Could a better spur to the patriotism of Councils be applied?

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## The Community Irrigation Pumping Plant

By E. EARL GLASS, C. E.

The individual pumping plant is probably the most satisfactory source of water supply for irrigation purposes where a perpetual gravity supply is not assured. Small ranchers may realize the advantages of the more efficient large plants by installing a co-operative plant on a centrally located well to serve the adjacent properties. Such a mutual equipment near Los Angeles, Cal., is furnishing water to 10 ranches having a total area of 125 acres of mature walnuts on a light, sandy loam soil. The plant, consisting of a 15-HP. motor, direct connected to a 6-in. horizontal centrifugal pump, sets at the level of the highest groundwater in a concrete lined pit 5 ft. x 6 ft. and 20 ft. deep. The greatest suction lift is 7 ft. and the total lift is 30 ft. With a power consumption of only 13½ kw. at 2 ct., this plant delivers a stream of 130 miner's inches (2.6 sec. ft.) for 27 ct. per hour. The plant cost $770, divided as follows:

| | |
|---|---|
| Well | $100 |
| Pit | 120 |
| Pump, motor and pipe | 500 |
| House and incidentals | 50 |
| Total cost | $770* |

*Or $6.20 per acre irrigated.

This plant is operated 12 hours per day during a four months' season, the ranchers using the entire stream in rotation. There is no attendance cost as the motor driven pumps require practically no attention. The total cost of operation is:

| | Per year. |
|---|---|
| Depreciation and repairs on plant | $ 39 |
| Interest on investment | 46 |
| Power, 19,500 k.w.h. at 2 ct | 390 |
| Total | $475 |

This is an annual cost of $3.80 per acre; $1.54 per acre-foot of water or ¼ ct. per miner's inch-hour. The difference between this rate and what they had been paying a commercial water company paid for the outfit the first season it was used. This is only an example of an economical irrigation plant and demonstrates the advantages of neighboring irrigators pooling their irrigation developments.

TABLE I—PUMPING PLANT LOG.

| Date. 1918. | Irrigator. | Meter readings, k.w.h. Start. | Stop. | Used | Charges at 2 ct. per k.w.h. A | B. | C | D. |
|---|---|---|---|---|---|---|---|---|
| Aug. 6...... | A | 4437 | 4599 | 162 | $3.24 | $.... | $.... | $.... |
| Aug. 7...... | A | 4599 | 4752 | 153 | 3.06 | .... | .... | .... |
| Aug. 8...... | B | 4752 | 4917 | 165 | .... | 3.30 | .... | .... |
| Aug. 9...... | B | 4917 | 5064 | 147 | .... | 2.94 | .... | .... |
| Aug. 10..... | C | 5064 | 5224 | 160 | .... | .... | 3.20 | .... |
| Aug. 11..... | C | 5224 | 5370 | 146 | .... | .... | 2.92 | .... |
| Aug. 12..... | D | 5370 | 5532 | 162 | .... | .... | .... | 3.24 |
| Total | | | | 1,095 | $6.30 | $6.24 | $6.12 | $3.24 |

A printed form (see Table I) was held in a frame beside the meter and each irrigator, upon starting the pump, noted the meter reading and again when he shut down, signing his name and entering beside it the power he had used and the charge to be made against him. The next user checked the last reading, as it should agree with his first figure.

# Findings of International Joint Commission on Pollution of Boundary Waters

Extracts from the final report of the International Joint Commission on the Pollution of Boundary Waters were given in a paper presented at the last annual meeting of the American Society for Municipal Improvements by Capt. F. A. Dallyn, Provincial Sanitary Engineer for Ontario, one of the engineering advisers of the Commission. As the report of the Commission was completed only recently and has not as yet been printed, the following outline of the findings abstracted from Capt. Dallyn's paper will be of interest

Section 7 of the conclusions of the Commission is probably the one of most vital interest today. This section is as follows:

> In order to remedy and prevent the pollution of boundary waters and to render them sanitary and suitable for domestic purposes and other uses and to secure adequate protection and development of all interests involved on both sides of the boundary, and to fulfill the obligations of the treaty, it is advisable to confer upon the International Joint Commission ample jurisdiction to regulate and prohibit this pollution of boundary waters and waters crossing the boundary.

It appears that the Commission does not ask for authority to regulate as it may deem advisable—without limit—but that it recommends that some authority (itself appearing as the most natural) be clothed with power to regulate as consistent with the spirit of treaty obligations and in a manner consonant with their findings and conclusions.

To determine the extent of remedial treatment required in each particular case would involve consideration of the varied lines that have been followed by the Commission throughout the present enquiry; the existence of pollution and of harm, actual or potential, to domestic or other uses, to public health or property; the results of the engineering studies of feasible remedies; and the economic facts relating to the conservation of stream resources. It would require the balancing of the value of remedial measures in the terms of public good against the cost of the requisite improvements.

On the one hand, it is evident that the paramount importance of public health and the binding obligations of the treaty must be borne in mind. These make impossible the recommendation of such lenient remedial measures as would work economic injustice or would endorse officially the continued spoilation of a natural resource to the injury of the citizens upon both sides of these waters.

On the other hand, sewage treatment requirements must not be made so excessive and unreasonable as to involve the cities and towns along these waters in an expenditure entirely unjustifiable. They should be reasonable and feasible from the standpoint of engineering construction or adaptability to local conditions, or the availability of necessary lands, out-falls, incidental structures, and costs.

**Standard for Detroit and Niagara Rivers.**—In view of the fact that pollution in the Detroit and Niagara Rivers, and its transboundary effects therein, are much greater than in the other boundary waters, these two rivers will be treated in one class and the remaining boundary waters as another class.

The problem of necessary bacterial purification of the sewage discharged into the two former is one of extreme perplexity; owing to the difficulty or impossibility of obtaining definite and ample data and the relative importance to be attached to many of the factors which enter into it.

After a great deal of consideration, the Commission has, in view of all the circumstances of the case, come to the conclusion that for the present, and as an immediate step in the way of restoration of the purity of these streams, the communities responsible for the discharge of raw sewage into them should purify it to such an extent that the resulting average cross-sectional pollution in each river will not exceed the limit of safe loading for a water-purification plant. In other words, the standard of purification required of these communities should be such that the streams, after receiving their treated sewage, would have a mean annual cross-sectional average of B. coli not exceeding 500 per 100 c.c.

Compliance with the requirements of this standard would not impose upon the riparian communities along these rivers discharging their sewage therein a burden which would be unreasonable or greater than that ordinarily imposed upon urban communities which purify their sewage.

**Water and Sewage Standards.**—It necessarily follows that this standard of sewage purification, being based upon a tentative standard of safe loading of water-purification plants, must itself be tentative. The growing appreciation of sanitation, the consequent demand for a higher degree of purity in water supplies, and the constant improvement that is taking place in the processes of sewage treatment tend to make a proper standard of sewage purification one of ever-increasing stringency. The discovery of a new and much more economical, or possibly a profitable, method of disposal of sewage, for example, would naturally lead to the adoption of a stricter standard of permissible pollution in heavily polluted streams. Furthermore, any limit of permissible impurity that might be established, even temporarily, for a given stream must be influenced largely by strictly local considerations.

The data necessary for the formulation of a fixed standard, either of sewage purification or of water purification, are not sufficiently well established at the present time. By more precise methods of experimental study there will doubtless be obtained in the future a more ample and accurate command of facts, which will admit of the determination of a more definite standard.

**Professor Phelps' Standard.**—In view of the difficulties and uncertainties of bacteriological technique, it is distinctly advantageous to have, if possible, a working rule which is more accurate and readily determinable than the bacterial standard suggested. Professor Phelps, the consulting engineer, taking the results of the extensive investigations reported upon in the "Progress Report" as an index of the conditions actually existing, worked out such a rule or standard.

He found that if the sewage of the cities be diluted in a stream flow to 4 cu. ft. per second per capita of the population, the resulting water will contain approximately 500 B. coli per 100 cc. If the dilution is proportionately less than this, a corresponding degree of purification of the sewage will be necessary to maintain the final stream condition. Further investigations will no doubt make possible a more accurate statement of these relations, but, as the entire matter of standards is always subject to revision in the light of accumulated knowledge, it is considered that for all purposes of a present inquiry, the practical equivalence of the dilution and the bacteriological standards may be accepted.

These standards are not applicable to rivers other than the Niagara and Detroit, but it is in no sense to be inferred, however, that remedial or protective measures are not required in their case, where the dilution, based upon the entire cross-section of the stream, exceeds in every instance 4 ft. per second per capita of the population.

**No Untreated Sewage Should Go Into Boundary Waters.**—The view of the advisory engineers is adopted that no untreated sewage should be discharged into boundary waters, but the Commission considers it inadvisable at the present time to prescribe what the amount of treatment should be in the case of these remaining rivers. The sewage from each community along their banks must be considered by itself in respect of the degree of purification that is necessary, basing the standard on the reasonable use of the waters, the practical possibilities of remedial and protective measures, the economic value of stream purification, and also the economic value of stream pollution, proper regard being had to the public health.

After giving much attention to the question of standards of purification in the six boundary rivers, the Commission has come to the conclusion that the fixing of standards for them and the subsequent modifications of these standards, from time to time, should be left to some authority clothed with the necessary power to deal with the question. This authority should also have power to vary, from time to time as conditions demand, the standards of sewage purification in the Detroit and Niagara rivers.

# Sanitary Aspect of Water Supplies at Army Cantonments*

By LT.-COL. JAMES T. B. BOWLES, N.A.

The water requirements of the cantonments, both from the standpoint of quality and quantity, have been anticipated by the Cantonment Division of the Quartermaster Corps remarkably well. No source has been so inadequate that there was such danger of shortage that it had to be supplemented by additional sources—no source was questionable from the sanitary standpoint to the extent that its use was prejudicial to health.

In the development of the water supplies, purity was not lost sight of. Construction quartermasters at the various cantonments were given blanket authority to purchase chlorinators. This was done in practically all cases, either one or more chlorinators being installed.

The development of supplies for the cantonments has been along the following lines:

(a) Purchase of water from municipalities where the camp was located within a reasonable distance from city and where the municipal plant had facilities to assume the additional load.

(b) Development of a special supply—a ground water supply where there was knowledge of water bearing strata, and where the cost of obtaining it was not prohibitive.

(c) Lastly, development of surface supplies, supplemented by a purification process where necessary.

Of 31 National Army and National Guard camps, 18 are supplied with water from municipal systems. Twelve of these are surface supplies, demanding such purification as will insure at all times a clear, colorless and sanitary water. Six are ground waters, requiring no purification, with possible exception of chlorination more as a prophylactic than a necessity. Most of these municipal systems have been found amply large enough to assume the demands of additional consumption without increased plant development.

Fourteen supplies were developed by the Cantonment Division; only three of these were surface supplies. One of these surface supplies utilizes water from a sparsely inhabited water shed, and as a sanitary precaution no other purification is necessary than chlorination. The other two are from polluted streams and require purification. Of the ground water supplies developed, none required purification other than chlorination. In the case of the western camps, where ground waters are used, softening for boiler and laundry purposes has been considered advantageous.

Supervision of quality of water has been conducted on the following lines:

(a) Inspection of municipal plants.

(b) Arrangements whereby frequent bacteriological examinations of all sources could be made.

The inspection of municipal plants revealed many interesting conditions. In many cases a modern up-to-date plant, supervised by live officials with a sense of the necessity of pure and wholesome water; but in too many cases, plants operating with a low margin of safety, and under the control of operators who had little knowledge of the kind of water the plant was turning out.

The inspection resulted in either assisting the city to secure competent men to supervise operation or to make arrangements whereby an officer of the Sanitary Corps would assume responsibility for the quality of the water.

Some authorities gladly and willingly co-operated in carrying out the improvements and changes recommended. Others reluctantly admitted that the quality of their water supply was not above suspicion. This latter class was usually the short-visioned, non-informed type of citizen, whose ideal of the best fulfillment of his position was in keeping a tight clutch on the purse-strings.

From the beginning of the cantonment activities, an effort was made to secure accurate bacteriological data concerning the various supplies. Prior to any definite knowledge of the potability of these supplies, it was assumed that they were all more or less polluted; or at least there was potential pollution and facilities for chlorination were installed.

In this the department had the co-operation of the manufacturers of the apparatus for applying liquid chlorine, who gave prior consideration to all Government orders. Analyses were made at the Army Medical School, Washington, D. C., and the Departmental Laboratories of the U. S. A.; by the Red Cross Units and the Public Health Service, and at the base hospital laboratories connected with the various camp hospitals.

In the early period of the camps, semi-weekly samples were collected and forwarded by express or mail to the nearest Government laboratory. Where the results of the analyses showed contamination, the camps were immediately informed by telegraph. The means of protection was chlorination, and where this was not possible an order was issued to boil all drinking water.

In the extra-cantonment areas, the U. S. Public Health Service included examination of water supplies in their routine work. This was of great assistance in checking up the operation of municipal supplies. A great many of these municipalities had no analytical data on their water supplies; furthermore there seemed to be no tendency on the part of the various State Boards of Health to exercise supervision or control. Where analytical data were available the interpretation corresponded to numerous and varied standards.

The standard of the Treasury Department as applied to interstate carriers was early adopted as the standard of water supplied to the cantonments.

In the early period of the camps, considerable apprehension was caused by the results of the analytical tests, which in many cases indicated gross pollution. This could be accounted for only as a result of construction. This pollution was in most cases temporary and gradually disappeared with continued use of wells and distribution systems.

Since the base hospital laboratories have been equipped, bacteriological analyses of water are now a part of the daily routine.

The results of sanitary water and typhoid prophylaxis have resulted in a remarkably small number of cases of typhoid and related diseases among the troops at the camps. From Sept. 14 to April 26, there have been 123 cases of typhoid with seven deaths, 315 cases of dysentery with one death. What quota of these cases is attributable to water it is impossible to say. Several of the typhoid cases developed in the early part of September and may have had their origin in civilian communities.

In conclusion the author would state that liberal application of chlorine, with close laboratory control and supervision, has resulted in a pure and wholesome water being supplied to the camps at all times.

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*From the September Journal of the American Waterworks Association.

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**Public Utilities Commission's Rulings on Water Rates.**—Increased rates for water service at Mount Vernon, Ill., have been authorized by the Illinois Public Utilities Commission. The new rates are: First 10,000 gal., 40 ct. gross; next 90,000 gal., 20 ct. gross; all over 100,000 gal., 15 ct. Fixed charges were established for service installation. The Commission also has granted permission to the Cairo (Ill.) Water Co. to raise its rates. An emergency surcharge of 20 per cent was authorized on all flat rates. The New Jersey Public Utility Commission has given permission to the New Jersey Water Service Co. of Hadden Heights, to exact a war surcharge of 20 ct. monthly from each connected customer. The company asked that a charge of 25 ct. be allowed.

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**2,000,000-Acre Irrigation Proposed for Rio Grande Valley.**—It is reported that members of the International Boundary Commission will make a favorable report to the United States and Mexican Governments on an irrigation project for the reclamation of 2,000,000 acres of land in the lower valleys of the Rio Grande. The tentative plans involve the building of an international dam across the Rio Grande at or near Roma, Tex., and the construction of large systems of canals and ditches on the American and Mexican sides of the stream.

# Flow of Water in Wash Water Troughs for Rapid Sand Filters

An investigation, having for its principal objects the determination of the surface curves for flow of water in wash water troughs and the development of a formula that would be of assistance to the designers of such troughs, was conducted recently at the hydraulic laboratory of Cornell University by Ernest C. Fortier and Frank V. Fields. The experiments were described by Mr. Fields in The Cornell Civil Engineer, from which the matter in this article is abstracted.

The galvanized iron trough (see Fig. 1) used in the experiments had a cross section approximating a rectangle surmounting a semi-circle of 7-in. radius. The section was the same as that used in the new filter plant at Cleveland, O. It also was recommended in the preliminary design of the filtration plant for Lima, O. The length of the trough used (20 ft.) was the same as that recommended for Lima. The troughs in the Cleveland plant, however, are of greater length.

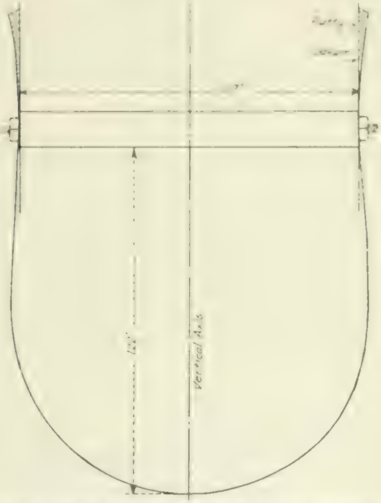

Fig. 1—Section of Trough Used in Experiments.

Four series of runs were made: first with the bottom of the trough horizontal, second, with the grade of 0.4 per cent, third with the grade of 0.8 per cent and fourth with the grade of 2.0 per cent. In each case the crests were horizontal and each side was as nearly the same elevation as it was possible to make them.

An abstract of the data, showing the results of each run is given in Table I. In each series the maximum flow was the capacity of the trough for that slope, the water completely filling the trough to the iron braces at some point in the trough.

TABLE I.

| Run No. | Grade per cent | Head on crest ft | Discharge c.f.s. | Condition of flow into trough. |
|---|---|---|---|---|
| 9 | 0.0 | [illegible] | [illegible] | Nappe free |
| 10 | [illegible] | [illegible] | 2.850 | Nappe free |
| 11 | 0.0 | [illegible] | 2.034 | Nappe free |
| 12 | 0.0 | .036 | 1.313 | Nappe free |
| [illegible] | [illegible] | .017 | 0.546 | Clinging flow |
| 14 | 0.0 | [illegible] | 2.034 | Nappe free |
| 15 | 0.4 | .079 | 3.565 | Nappe free |
| 16 | 0.4 | .0555 | 2.218 | Nappe free |
| 17 | 0.4 | .038 | 1.439 | Nappe free |
| [illegible] | 0.4 | .022 | 0.423 | Clinging flow |
| [illegible] | 0.4 | [illegible] | 0.546 | Clinging flow |
| 20 | 0.8 | [illegible] | 3.764 | Nappe free |
| 21 | 0.8 | .064 | 2.629 | Nappe free |
| 22 | [illegible] | .038 | 1.413 | Nappe free |
| [illegible] | 0.8 | .014 | 0.181 | Clinging flow |
| [illegible] | 2.0 | .091 | 1.323 | Nappe free |
| [illegible] | 2.0 | [illegible] | [illegible] | Nappe free |
| [illegible] | 2.0 | .047 | 1.710 | Nappe free |
| [illegible] | 2.0 | .012 | 0.387 | Clinging flow |

**Discussion of Results.**—The principal aim of the investigation was to determine the capacity of this trough, and also to work out, if possible, some formula that would aid in designing troughs of similar section. It was especially desirous to determine the effect on the capacity of putting the bottom of the trough on a slope, instead of horizontal, as is the custom in practice.

The profiles of the water surface in the trough are made up of two parabolas, each of the form—

$$Y = m x^{n}$$

where Y is the depth at any point and x is the distance of the point from the discharge end of the trough.

From the intercepts of these curves on the line $x = 1$, and the values of Q for the runs, the coefficient m is found to be—

$$m = .458\,Q^{\text{[illegible]}}$$

for the level series. The slope of the curves gives the value of n as .138 for the parabola in the lower end of the trough. Similarly for the parabola in the upper end of the trough, the coefficient m is .587 $Q^{.548}$ and the value of n is found to be .032. The equations of these curves are then, for the lower parabola—

$$Y = .458\,Q^{\text{[illegible]}}x^{.138}$$

and for the upper parabola,

$$Y = .587\,Q^{.548}x^{.032}$$

These equations were determined for the series with the trough in a horizontal position and lines of the same slope have been drawn through the points obtained for the other series. They fit fairly well except for the low flows, where they evidently do not fit at all. It might be well to point out here that the curves on logarithmic paper do not represent the depth in the trough, except in the level series, but are plotted between distance from the discharge end of the trough and the height of the water surface above the discharge end of the trough.

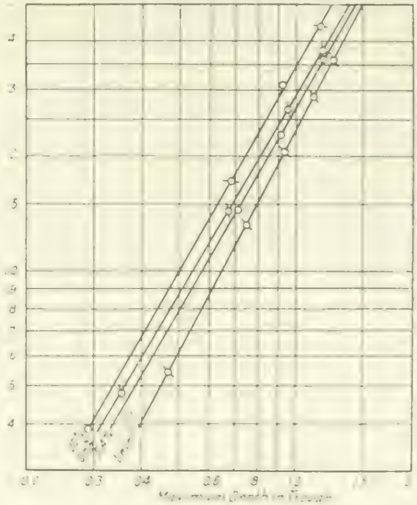

Fig. 2—Maximum Depth in Troughs for Various Discharges

For the level series the points of intersection between the lower parabola and the one in the upstream end of the trough, also lie on a parabola, and its equation is—

$$z = 10\,Q^{\text{[illegible]}}$$

where z is the distance from the discharge end to the intersection of the two parabolas.

By plotting the surface profiles on cross-section paper, the maximum depths in the trough for all runs were determined and these are plotted in Fig. 2 as abscissas and the corresponding values of Q are plotted as ordinates. These curves show that the discharge varies as some power of the maximum depth in the trough and that this exponent is very nearly the same for the three higher grades. The slope of the trough does not seem to affect the exponent but is a factor in the coefficient of the equation. The equation is of the form—

$$Q = m\,[1 + f\,(s)]\,d^{n}$$

where s is the per cent slope and d is the maximum depth occurring in the trough. The equation is found to be—

$$Q = 2.28\,(1 + .295\,s^{\text{[illegible]}})\,d^{1.74}$$

This formula does not hold exactly for the level condition and since it is the practice to set these troughs level in actual installations, it might be well to give the formula that applies strictly to the level condition as indicated by these experiments, which is—

$$Q = 2.28\,d^{1.61}$$

This condition of flow has been discussed by Mr. C. N. Miller.* The formula derived by Mr. Miller for a rectangular trough is—

$$Q = 1.91\,b\,(y + l\tan\alpha)^{\text{[illegible]}}$$

where b is the width of the trough, y is the depth in the upstream end, l is the length of the trough and α is the angle between the bottom of the trough and the horizontal. Mr. Miller states that for any other section of trough it can be reduced to an equivalent rectangular section and then his formula can be applied. It seems that there would be three "equivalent rectangular sections"; one with the same width, another with the same depth and still a third with the same hydraulic radius, all of which would have the same area. Upon investigation, however, it will be found that no rectangular section can have the same area and hydraulic radius as a section that is made up partly of a semicircle; as the section under consideration is made up of a semicircle surmounted by a rectangular area, only the first two equivalent rectangles will be considered. The values of Q for the maximum quantity and one of the lower quantities have been computed according to the formula mentioned, for each setting of the trough and are given in Table II. The values found by experiment are also given for comparison.

It will be seen from Table II that the discharge for the trough used as computed by Mr. Miller's formula, gives results that are from 6 per cent to 19 per cent too small.

The discharging capacity of a trough of the same cross-section but for lengths other than 20 ft., cannot be foretold from these experiments.

**Conclusion.**—The design of wash water troughs for slopes up to 2 per cent and of sections similar to that used in these experiments can be aided by the use of the formulas given or from Fig. 3. If the quantity of water to be handled is known, the number of troughs can be assumed and the maximum depth, hence the section, computed. In general it has been the practice to set these troughs level, and in such a case the trough is of uniform section throughout its length. If the bottom is set on a grade, the section is smallest at the upstream end and increases uniformly to the downstream end. In this condition the maximum depth may not occur at the upstream end but at some point farther down in the trough. The amount of metal for either level or sloped setting would be about the same, but the 2 per cent setting gives an increase in capacity of about 22 per cent over the level setting. The flatter slopes give only a small increase in capacity and therefore are of no commercial importance.

There is another factor that should be given some thought when designing these troughs. The capacity for this trough as stated in this article, is based on that section of the trough below the lower edge of the row of iron braces that hold the crests apart. These braces are bolted through holes in the trough itself, hence the row is always parallel to the bottom of the trough. In an actual installation there would be fewer of these braces and they would be so placed as to give minimum resistance to the flowing water, hence the whole section of the trough would be used.

Still another factor to be considered is the effect of "flooding" the trough; that is, increasing the flow until the trough is under water. Such a flow was obtained on the 2 per cent setting, and showed a discharge of 9.26 cu. ft. per second. This flow cannot be used as a criterion, however, since there is a considerable section in this trough above the iron braces and also the effect on the area of these iron braces is uncertain. The total area of the trough for this run was 1.88 sq. ft. at the upstream end and 2.26 sq. ft. at the lower end. This seems to indicate that where a trough is designed so that it will carry the expected flows within its section, it will have an overload capacity of possibly 50 per cent when flooded.

TABLE II—VALUES OF Q FROM MILLER FORMULA AND FROM EXPERIMENT.

| Grade of trough | Area sq. ft. | l tan α. | b | Equiv. y. | Q by formula. | Q by experiment. |
|---|---|---|---|---|---|---|
| Level........ | 1.395 | .00 | 1.17 | 1.192 | 2.907 | 3.539 |
| Level........ | 0.767 | .00 | 1.17 | 0.655 | 1.185 | 1.313 |
| 0.4%......... | 1.300 | .08 | 1.17 | 1.111 | 2.907 | 3.565 |
| 0.4%......... | 0.698 | .08 | 1.17 | 0.596 | 1.241 | 1.439 |
| 0.8%......... | 1.245 | .16 | 1.17 | 1.064 | 3.028 | 3.764 |
| 0.8%......... | 0.590 | .16 | 1.17 | 0.504 | 1.201 | 1.413 |
| 2.0%......... | 1.110 | .40 | 1.17 | 0.949 | 3.502 | 4.323 |
| 2.0%......... | 0.445 | .40 | 1.17 | 0.381 | 1.542 | 1.710 |
| FOR Y = DEPTH IN THE UPSTREAM END. | | | | | | |
| Level........ | 1.395 | .00 | 1.093 | 1.275 | 3.100 | 3.539 |
| Level........ | 0.767 | .00 | 1.022 | 0.750 | 1.268 | 1.313 |
| 0.4%......... | 1.300 | .08 | 1.090 | 1.192 | 2.990 | 3.565 |
| 0.4%......... | 0.698 | .08 | 1.003 | 0.695 | 1.330 | 1.439 |
| 0.8%......... | 1,245 | .16 | 1.088 | 1.145 | 3.090 | 3.764 |
| 0.8%......... | 0.590 | .16 | 0.968 | 0.610 | 1.251 | 1.413 |
| 2.0%......... | 1.110 | .40 | 1.072 | 1.035 | 3.530 | 4.323 |
| 2.0%......... | 0.445 | .40 | 0.900 | 0.495 | 1.455 | 1.710 |

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*In the book, "Water Purification," by J. W. Ellms.

## Efficiency of Lime for Correcting Acidity in Sludge

During 1916 the two Imhoff tanks at the Pennypack Creek sewage treatment works of Philadelphia, Pa., were operated experimentally in order to determine the efficiency of lime to correct acidity in the sludge. The results of this test are outlined in the 1917 report of Chester E. Albright, Chief Engineer Bureau of Surveys:

No lime was added to Tank No. 1, while 10 lb. of lime, slaked in water, each day were allowed to trickle into the sludge in Tank No. 2.

On March 21, 1917, 21 cu. yd. of sludge were withdrawn from Tank No. 1. This sludge was undigested, contained considerable fat in appreciable sized pieces, the moisture content was about 87.6 per cent, and the sludge required about five weeks to dry on the drying beds. The chemical analysis under cold test showed acidity 831 parts per million and of the dry residue 20 per cent was fat.

On April 4, 50 cu. yd. of sludge were withdrawn from Tank No. 2. This sludge was well digested, and required about three weeks to dry on the drying beds. The chemical analysis under cold test showed acidity 260 parts per million, and of the dry residue 17.2 per cent was fat.

A comparison of the qualities of these sludges strengthened the belief in the efficacy of lime to correct acidity, and beginning April 6, 1917, lime slaked in water (15 lb. to each tank) was added daily. Table I shows the improvement in the sludge of Tank No. 1 after the addition of lime.

TABLE I.

| Tank No. 1. Date withdrawn. | Mar. 21, 1917. | Apr. 25, 1917. | June 6, 1917. | Aug. 1, 1917. | Oct. 10, 1917. | Average for Tank No. 2. |
|---|---|---|---|---|---|---|
| Specific gravity.......... | 1.023 | 1.027 | 1.029 | 0.996 | 1.062 | 1.073 |
| Acidity cold ............ | 831 | 720 | 346 | 139 | 100 | 131 |
| Acidity hot.............. | 875 | 1.120 | ..... | 94 | ..... | ..... |
| Alkalinity hot........... | .... | ..... | 540 | ..... | 635 | 376 |
| Percentage moisture.... | 87.6 | 87.3 | 84 | 86 | 86.5 | 87 |
| Percentage of dry residue that is volatile... | 42 | 56 | 54 | 46 | 39 | 43 |
| Percentage of dry residue that is fixed...... | 58 | 44 | 46 | 54 | 61 | 57 |
| Percentage of dry residue that is fat........ | 20 | 19 | 21 | 18 | 10 | 13 |
| Drying on beds......... | [1] | [2] | [illegible] | [4] | [5] | [4] |
| Characteristics as to digestion ............... | [6] | [6] | [3] | [4] | [4] | [4] |
| Cubic yards withdrawn. | 21 | 29 | 46 | 46 | 42 | |
| | | | | | Total...... | 184 |

[1]Very slowly. [2]Slowly. [3]Fair. [4]Good. [5]Very good. [6]Poor.

**Eighty Per Cent Increase in Cost of Laying Water Mains.**—The average cost in 1916 of laying 6-in. water mains at Council Bluffs, Ia., was $5,187.60. In the fall of 1917, according to the last annual report of the water works trustees, the cost had increased to $9,636.

# Methods of Measuring Irrigation Water Deliveries to Farms*

By J. S. LONGWELL.

[illegible]

**Measurement by Floats.**—Measurements are occasionally made by means of floats dropped in the stream. Several floats should be used and they should be allowed to float for approximately 100 ft. during the observation. The rate of flow of each float should be observed and the velocity of the float covering the distance in the shortest time should be taken. This velocity is then multiplied by a coefficient varying from 0.6 to 0.9 depending on the size of stream and condition of the channel. The cross section of the stream is obtained and this multiplied by the reduced float velocity gives the discharge. This, of course, gives only an approximation of the discharge and should only be used where no better method is available.

**Rating Flumes.**—Rating flumes have been used to some extent in the older irrigation districts and are still in use in some localities. The rating flume consists usually of a small timber flume set in the farm lateral at a sufficient distance below the headgate so that the flow will not be influenced by the velocity of the water as it issues from the gate. A gage is set on the side of the structure so that it shows the depth of water passing through the flume. Measurements are made with a current meter for the various depths of flow in the flume. The measurements are plotted and a rating curve and rating table worked out. This table shows the discharges for all depths of water passing through the flume. If conditions below the flume remain the same throughout the season as existed at the time of making the rating, the rating will not change and the results will be very reliable. However, in most farm ditches this condition does not exist, the farmer usually has checks located in his ditch for use in irrigating the higher ground adjacent to the canal or lateral. As soon as he checks the water, unless there is a large fall between the flume and the check, the water will be held up in the flume and stand at a much greater depth than shown on the rating table for this discharge. Growths of weeds and moss and deposits of silt produce the same effect. Each of these conditions makes the rating table of no use and renders the flume useless unless frequent measurements are made throughout the season.

**Headgates.**—Many projects use the farm headgates for making measurements of all water delivered to the farms. Gages are set above and below the gates and the gate stem is marked in some way so that the gate opening can be obtained. To obtain the flow through the gate it is then necessary to determine the proper value of the discharge coefficient "C" in formula $Q = CA\sqrt{2gh}$. This is determined either by a careful rating of one particular gate or by numerous measurements on different gates.

It is found that the coefficient for headgates, even though they are all of the same general design, varies materially throughout the season. This is due to velocity of approach, silt deposits above the gate, varying contraction conditions at the inlet and different recoveries of velocity head at the outlet. Each of these conditions tends to change the coefficient and reduce the accuracy of the headgate as a measuring device. On the Minidoka project these coefficients for a 12 by 18-in. gate were found in some 600 tests to vary from 0.5 to a value greater than 1 with a mean value of 0.75.

One gate may be located so that the water drops at the end of the structure, another may be set several feet below water surface in the farm ditch, and still another may be located with conditions below the structure such that a portion of the velocity head is recovered. Each one of these will have a different discharge coefficient. Thus unless a number of measurements can be obtained on each turnout during the season, and the correct value of "C" determined for various conditions of flow, the accuracy of the results is very questionable.

**Weirs.**—By far the most prevalent type of measuring device used in the measurement of water to the farmer is the weir. Various types of weirs are used in different localities, the most common of these types being—

1. Cipelletti weir.
2. Rectangular weir with end contractions.
3. Rectangular weir with end contractions suppressed.

Of these types the Cipolletti weir is doubtless the most extensively used. The discharge is obtained from the familiar formula $Q = 3.367\ Lh^{\frac{3}{2}}$ the effect of end contraction being taken care of by the batter given the ends. The rectangular weir with end contractions is also used extensively, its discharge being given by the formula—

$$Q = 3.33\ (L - .2h)h^{\frac{3}{2}}.$$

Both of these types of weirs will give good results, there being no particular preference as to accuracy. In order, however, to obtain good measurements with either of them, it is necessary that they be provided with stilling pools immediately above or that provision be made for determining the velocity of approach. The structures should not be located too close to the turnout in order to avoid the high velocities usually prevalent at those points. In cases where it is impossible to obtain a stilling pool of sufficient length below the turnout, baffles are frequently used and the length of pool reduced. The rectangular weir with contractions suppressed has not been used to any great extent generally although in the State of Utah it is used considerably. The accuracy of this type of weir depends on obtaining the height of the crest above the floor of the channel of approach, as well as the depth of water over the crest. Even on projects where the silt conditions are not severe, there is always more or less silting and hence a changing of the height of the crest and in turn a constant necessity for obtaining the height of the crest.

On those projects where the silt problem is very severe, the Cipolletti and rectangular weir with end contractions are not practicable as the stilling pools soon fill up and the water runs in a narrow channel to the weir, thus vitiating the results unless the velocity of approach is obtained and corrections applied. The rectangular weir with end contractions suppressed is, however, better suited to these conditions than the other two and it is believed that by measuring the height of the crest each day fairly reliable results can be obtained, even with bad silt conditions.

In all of the above cases it is essential, for the best results, that the weir crest be set sufficiently high so that the water in the ditch below the weir will not back up above the crest. It is difficult in locating weirs to determine just where the water will stand in the farmer's ditch, as the extent to which his ditch will fill up with silt or be fouled by weeds and moss is very problematical. It is also necessary to be careful that the weir crest is not set so high that the operation of the canal or lateral is interfered with; that is, that it is necessary to maintain a very high water surface in the canal or lateral in order to put the required amount of water over the weir. In such cases it is not only difficult to operate the canal, but it is also very disagreeable to the water user, as any slight drop in water surface in the canal shuts his water off

In such cases it is better to set the weir lower and operate it a part of the time as a submerged weir or to adopt a different type of measuring device. The weir may submerge to a depth equal to one-tenth of the height of water over the crest and not affect the flow over the weir. Tables are available giving the effects for greater submergence, but it is believed that in cases where a greater submergence than one-tenth of the head on the crest is obtained for any length of time the crest should be raised or a different type of device used. In all weir installations accurate gages reading to hundredths of feet should be used. For all practical purposes these may be nailed to the head wall of the weir, care being taken to keep them set back about 18 in. from the sides of the weir opening.

**The Submerged Orifice.**—In cases where it is found impracticable to use a weir on account of lack of sufficient available head or from operating conditions, the submerged orifice is very frequently used. The advantages of submerged orifices are that they require only a small head to operate and also that they are set sufficiently low so that even for small discharges it is not necessary to check the water in the canal or lateral in order to force the water through them. They should always be set with the opening at least as low as the farm lateral.

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*From an article in the October Reclamation Record.

The submerged orifice requires a stilling pool above the structure to eliminate velocity of approach. The same requirements as to the stilling pool apply as in the case of weirs. Since stilling pools are required, the submerged orifice has the same drawbacks as the weir in all places where the silt is bad, and should not be used.

In setting the orifice, care should be taken to set the orifice opening sufficiently low so that the opening is submerged at all times. For the usual farm deliveries on the Minidoka project it was found that the water on the downstream side of the opening should stand approximately 1 ft. above the top of the opening to give good results. The upper gage is set on the headwall to one side of the orifice opening.

The gage on the downstream side of the opening should be set immediately below the opening so that the actual pressure head on the gate opening will be obtained and the effect of recovery of velocity head avoided.

At least 0.2 ft. should be provided for measurement to insure good results, and the size of opening should be arranged accordingly. In case the quantity of water delivered varies greatly it may be necessary to install a gate on the orifice so that the size of orifice may be regulated for different flow conditions. The gate stem in this case should be so marked that the area of opening being used is shown direct as 1 sq. ft., 2 sq. ft., etc.

Since the orifice must be set low in order to insure submergence, the natural shape is a long narrow opening. Naturally these tend to collect weeds and trash and more or less trouble may result.

It has been found that good results can be obtained by combining the orifice and turnout into one structure and placing it in the ditch bank. The orifice opening is placed in the front wall and the regulating gate is located back of it. In this manner the head used for the turnout is utilized for measuring the water and the regulating gate is made sufficiently large so that there is practically no loss through it. A stilling pool is done away with, as the canal or lateral serves as a stilling pool; it is only necessary to maintain one structure instead of two and much less trouble is experienced with the weeds than where the stilling pool is used. A gate to regulate the size of orifice opening can be used if necessary as described above.

**Venturi Flume.**—This device has not been used to any great extent as yet, but theoretically and from what tests have been made it should prove a very good measuring device in many instances.

The same principle applies to this device as to the Venturi meter except that the area varies in the flume, whereas in the meter it is constant. The device consists of a converging section leading from the lateral section to a narrow throat and then a diverging section leading back from the throat to the lateral section. Due to the increase in velocity as the water passes through the throat section, a decided drop in the water surface takes place. In the diverging outlet, if properly designed, the greater portion of the change in velocity head between the throat section and the lateral section may be recovered and thus only a very small overall loss will be required.

The measurement is based on the drop in the water surface from a point at the upper end of the flume to the throat section and also on the depth in the throat. Stilling wells are usually used at each of these points and the zero of the gages used is set level with the floor in the throat. Thus a reading of the two gages will give the drop in water surface and also the depth in the throat. It is necessary to calibrate these devices for various drops of water surface and depth of water in the throat and to prepare rating curves and tables.

The height of the water surface below the structure does not need to be considered after having rated the flume for the various conditions of flow.

In cases where there is a decided range of flow it is necessary to design the flume so that a good measurement will be obtained for the low as well as the high discharges and still keep within the limits of head available for the maximum flow.

Where a check is located below the flume, it may be that during a period of small flow the water is checked up to about normal water surface elevation. This will reduce the velocity in the throat to such an extent that no drop will occur in the water surface. Moss or weed growths also have a tendency to produce the same effect. In such instances as these, this type of device is not practical and should not be used.

Providing it can be standardized so that it is not necessary to rate each structure, this device should prove satisfactory on projects where silt conditions are bad, as the velocity of the water above the flume does not affect the measurement and there is no pool to fill up.

Up-to-date tests on this type of device have been very limited and it is not known just how successful it will prove when used under the variable conditions found in farm deliveries.

It has the advantage of requiring no stilling pool, very little head, and offers no obstruction to weeds and trash.

**Venturi Meters.**—Venturi meters have been used only to a small extent in measuring irrigation water. They have an advantage over the flume in that the area of the throat is constant for all quantities and thus only the drop in pressure head from a point above the meter to the throat is required.

Recording mechanisms are on the market for these meters. These show the total flow in acre-feet that has passed through the meter and do away with the necessity of computing the water records. However, these mechanisms are too expensive to be used very extensively for farm installations. The flow through the meter in second-feet can, however, be obtained by the reading of the two gages as in the case of the Venturi flume.

For the usual farm requirements the throat is so small that weeds and thrash can not pass through and it is difficult to get weeds out after they are once jammed. Thus unless a trash rack is used or the throat is sufficiently large to pass the weeds, they are likely to give more or less trouble.

**Dethridge Meter.**—Various other devices for measuring water to the farmer have been used, but none to any large extent. Among these are the Dethridge meter which has been used in Australia. This device consists of a drum with projecting vanes, mounted on a shaft and set in a box in the farm lateral. As the water passes through the box it turns the wheels and the wheel is calibrated so that the number of revolutions per minute is equivalent to a certain flow. The device is simple and gives good results, but has the serious defect of jamming with weeds. This stops the wheel and will put the water over the ditch banks unless taken care of.

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**Propose Spending $20,000,000 for Hydro Electric Development.**—A program for the expenditure of $20,000,000 for hydro electric developments in California and Oregon has been recommended to the War Industries Board. The plan calls for the furnishing of $20,000,000 provided by the War Finances Corporation, the Sims bill appropriation, and the electric power corporations of Superior, Cal. Among the proposed development phases are: Addition of 36,000 kw. to the Sierra & San Francisco Power Co. system on the Stanislaus River. Increased storage to develop 25,000 additional kw. on the Pacific Gas & Electric Co.'s system. Development at Lake Almanor and on the Feather River to increase the Great Western Power Co.'s supply by 50 per cent, or 40,000 kw. Development of 50,000 kw. annually for 3 years at Sheep Rocks on the Pitt River. The construction of a 300,000-volt power line from the Rogue River in Oregon to supply the city of San Francisco. The heaviest power line now carries but 110,000 volts.

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**Wisconsin Cities on Lake Michigan May Erect Sewage Disposal Plants.**—It is reported that a bill will be introduced at the 1919 session of the Wisconsin Legislature to compel cities located on Lake Michigan or rivers emptying into the lake to install sewage disposal plants.

# Methods of Preventing Freezing of Riser Pipes

Useful suggestions on the care of riser pipes of water tanks during the winter season are given in October issue of The Water Tower, a publication of the Chicago Bridge & Iron Works. The following notes are taken from the above mentioned journal:

The freezing of riser pipes during extremely cold weather can be prevented by four means:

1. Providing method for artificially heating the water in the riser pipe.

2. Conserving the heat in the water by providing sufficient insulation to prevent loss of heat.

3. Maintaining the temperature of the water above freezing point by pumping and withdrawal of the water.

4. Adding certain chemicals which will lower freezing point.

Frost casings which are now almost universally used and which are designed and approved by insurance underwriters and consulting engineers, are only a partial protection.

Sprinkler tanks in which there is practically no circulation, require frost casing and in addition, means of supplying artificial heat. This can be done by either—

(a) A steam coil in the bottom of the tank with the steam supply and return pipes running inside of the frost casing and next to the riser pipe.

(b) A system of hot water circulation applied at the base of the riser either by means of hot water heater, which may be fired with gas, oil, or coal, or by a special heater in which steam is the primary source of heat. In this type of heater cold water is taken out at the base of the riser, passed through the heater and put into the tank through a 2-in. pipe.

(c) When conditions prevent either of the above methods being employed, it is possible to inject live steam into the tank, thus keeping the water in the tank and riser warm.

Where there is only occasional service from the tank, and therefore, intermittent circulation, a more or less elaborate frost casing may be used to prevent freezing.

In tanks for municipalities, artificial heat is rarely applied and the ordinary type of frost casing is depended upon to prevent freezing. This is usually satisfactory, because there is almost constant circulation in the riser. The most frequent practice is to operate pumps during the day to take care of the requirements of the town and also to have the tank filled by evening. At night the pumps are not operated and such water as may be consumed by the town is drawn from the tank. Pipes through which the water circulates from the pump house to the tank, are laid well below the frost line in the warm earth, and the water in passing, even if it is drawn from a cold reservoir or river, is usually warmed well above the freezing point by the time it reaches the tank riser. If the water is drawn from a well, the temperature will seldom be found to be below 50° F. The tank is, therefore, filled with the water well above the freezing point and there being almost constant circulation in the riser, there is little danger of freezing.

When a municipal water works system is placed in service, there is usually very little consumption and, therefore, very little circulation in the riser. In such cases care should be taken to draw off and pump a reasonable amount of water each day, so as to provide what we call artificial circulation. This can perhaps best be done by opening fire plugs in the morning and drawing the water well down ad refilling the tank during the day.

In occasional water system installations such precautions are not taken, with the result that during the extremely cold weather riser pipes freeze and the city is called upon to bear an expense which could be prevented with a little care.

The same condition is liable to arise on tanks which are furnished for private estates, farms or for other purposes where the water is only used intermittently. Either artificial heat must be provided or more or less rapid circulation be maintained by alternate drawing off and refilling the tank. This condition is usually exaggerated on small tanks because the service pipes are small.

Superintendents of water works for municipalities and engineers of industrial establishments should take particlar care to see that there is circulation at all times in the riser pipe of tanks during cold spells of the coming winter. Should you be so unfortunate as to have the riser of your tank freeze up, you should take prompt action to thaw it out, for by so doing you may prevent your pipe from bursting.

In case of a freezeup the following method has been found most satisfactory in thawing out. Make a 1-in. tap in the foot elbow, and another one in the riser pipe about 4 ft. above the first opening, then connect a steam line from an ordinary boiler into the top hole, turn on the steam "not over 100-lb. pressure per square inch" and in a short time water will begin to drain out of the hole in the foot elbow; leave the steam turned on until the water in the tank begins to run out.

All of these points apply equally well to any other kind of a tank with a small riser pipe, instead of a large cylinder.

# Operating Results of Slow Sand Filtration Plant of Providence, R. I.

The total quantity of water filtered by the slow sand filters of Providence, R. I., in 1917 was 7,246,650,000 gal., according to the last annual report of M. H. Bronsdon, City Engineer. This is an average of 2,157,000 gal. per day for each of the 10 filters. Each filter was scraped an average of 17 times during the year and the average total hours of service for each was 8,063.9. The average quantity of water filtered between scrapings was 42,630,000 gal. The maximum run was 73.17 days; the minimum run 6.38 days and the average run 19.75 days. The average maximum loss of head per filter was 4.13 ft. The monthly averages of bacteria per cubic centimeter was as follows:

24-HOUR COUNTS ON STANDARD AGAR AT 37° C.

| Month | Raw water. | After filtration. | After chlorination. | Tap in laboratory. | Per cent remaining. After filtration. | Per cent remaining. After chlorination. |
|---|---|---|---|---|---|---|
| January | [illegible] | [illegible] | .. | | [illegible] | . |
| February | [illegible] | [illegible] | . | | [illegible] | |
| March | [illegible] | [illegible] | .. | .. | [illegible] | ... |
| April | 400 | 10 | .. | .. | 2.5 | ... |
| May | [illegible] | [illegible] | | | [illegible] | |
| June | [illegible] | 12 | [illegible] | [illegible] | [illegible] | [illegible] |
| July | [illegible] | 31 | [illegible] | [illegible] | [illegible] | [illegible] |
| August | 1,470 | 23 | 14 | 20 | 1.6 | 1.0 |
| September | 1,450 | 30 | 13 | 26 | 2.1 | 0.9 |
| October | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| November | [illegible] | [illegible] | [illegible] | 4 | [illegible] | [illegible] |
| December | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Average* | 1.680 | 20 | 10 | 12 | 1.2 | 0.4 |

*Average represents the total number of samples taken.

[illegible] figures showing the results of chlorination are for the months of [illegible] to December, inclusive.

The average color of the river water for 1917 was 43 and for filtered water 28, thus giving a removal of 34.9 per cent.

**33% of Urban Population Uses Filtered Water.**—Filtration has been practiced for many years; first in England, subsequently in Germany, and for the last 25 years in this country, the number of supplies in the United States treated by filtration having increased enormously since the building of the Lawrence filter in 1892-1893. At the present time there are in this country about 740 communities supplied with filtered water. In 1890 about 300,000 of our population were so supplied, and at the present time about 18,500,000. If, as is estimated, our total urban population is about 50,000,000, 33 per cent of this population now uses filtered water. Probably nothing in modern science has been of greater importance in this country, taken as a whole, in overcoming epidemics or preventable diseases, than filtration. Filtration is, with properly constructed and operated filters, an efficient and dependable method of control for safety.—H. W. Clark, Director and Chemist Division of Water Laboratories, Massachusetts State Department of Health, in a paper presented recently before the School of Public Health, Boston, Mass.

**Eight Per Cent Increase in Cost of Water Works Operation at Council Bluffs.**—The cost of operation and maintenance of the water works of Council Bluffs, Ia., during 1917 amounted to $62,434, or $52.60 per 1,000,000 gal., as against $53,163 in 1916, or $48.78 per 1,000,000 gal., an increase of 7.84 per cent. This increase, states the last annual report of Superintendent S. L. Etnyre, is due mainly to the increased cost and inferior grade of coal and to the increased cost of labor and supplies.

# Life of Wooden Water Tanks in Railway Service

Interesting data on the life of wooden tanks were given by Mr. C. R. Knowles, Superintendent Water Service, Illinois Central R. R., in a paper presented at the last annual convention of the American Railway Bridge and Building Association. In collecting the information letters of inquiry were sent to 45 railroads and 27 answers were received.

While much valuable information was obtained from the replies, the figures and estimates given as to the life of tanks were almost as many as the replies received.

The variation in the figures submitted on the life of timber on various railroads goes to show that no accurate estimate may be made on the life of tank timber that will apply to all sections of the country. It is characteristic of timber that it is more durable when used in the region in which it is grown than when used elsewhere, for nature seems to have fortified the timber against decay to a certain extent when it is kept in its native climate.

One railroad reported 77 redwood tanks in service in California ranging from 26 to 48 years old, while another road reported redwood tanks renewed in Wisconsin after only 15 years of service. Twelve white pine are reported in service in Michigan, with an average life of 35.4 years, while it has been necessary to replace white pine tanks in Missouri after 12 to 13 years. A Texas road reports cypress tanks in service as follows:

5 tanks 31 years old,
8 tanks 30 years old,
3 tanks 29 years old,

while several eastern roads fix the maximum life of cypress at 25 years.

Table I shows the life of 310 tanks, 184 of which are still in service, and 126 of which have been relieved. In preparing this tabulation only figures were used where the definite life of the tank was given.

TABLE I.

**Average Life of 184 Tanks in Service.**

| | | | |
|---|---|---|---|
| REDWOOD. | | | |
| Railroad "A" | 77 tanks | Average life 32.6 | years |
| CYPRESS. | | | |
| Railroad "B" | 29 tanks | Average life 28.3 | years |
| Railroad "C" | 25 tanks | Average life 25 | years |
| Railroad "D" | 3 tanks | Average life 32 | years |
| WHITE PINE. | | | |
| Railroad "A" | 24 tanks | Average life 29.7 | years |
| Railroad "E" | 12 tanks | Average life 35.4 | years |
| Railroad "F" | 4 tanks | Average life 29 | years |
| Seven Railroads | 184 tanks | Average life 30 | years |

**Average Life of 106 Tanks Relieved.**

| | | | |
|---|---|---|---|
| CYPRESS. | | | |
| Railroad "B" | 24 tanks | Average life 27.3 | years |
| Railroad "G" | 16 tanks | Average life 30 | years |
| Railroad "D" | 3 tanks | Average life 32 | years |
| | 43 | 29 | years |
| WHITE PINE. | | | |
| Railroad "H" | 27 tanks | Average life 27.5 | years |
| Railroad "B" | 22 tanks | Average life 25.8 | years |
| Railroad "I" | 14 tanks | Average life 23 | years |
| Railroad "F" | 4 tanks | Average life 29 | years |
| Railroad "D" | 3 tanks | Average life 33 | years |
| Railroad "E" | 3 tanks | Average life 38.3 | years |
| Railroad "C" | 5 tanks | Average life 27 | years |
| | 78 | Average life 27 | years |
| YELLOW POPLAR. | | | |
| Railroad "C" | 3 tanks | Average life 30 | years |
| RED CEDAR. | | | |
| Railroad "C" | 1 tank | Average life 28 | years |
| YELLOW PINE. | | | |
| Railroad "C" | 1 tank | Average life 29 | years |
| Eight Railroads | 126 tanks | Average life 28 | years |

It will be noted that the white pine tanks show a higher average life than the cypress tanks in the table of tanks still in service while the opposite is true in the table of tanks relieved. This may be explained by the fact that cypress tanks were not used as extensively as white pine tanks up to 20 years or so ago, and on the roads shown there are probably many white pine tanks which were in use before cypress tanks were constructed, although there is apparently very little difference in the durability of the two woods.

It is interesting to note that a yellow pine tank is shown with a life of 29 years while the life of a yellow pine tank as constructed today would probably not exceed 12 years. This difference in life can probably be explained in the fact that the trees from which the tank mentioned was cut had not been bled of the rosin and preservative oils natural to the wood. It should be explained that the life of 28 years given the red cedar tank did not represent the extreme life of the timber as when the tank was taken down the best of the timber was used in the construction of a smaller tank which is still in use. The original tank was constructed in 1870, which makes the timber in the smaller tank 48 years old.

In the letters received many records were given showing a life of only 10 to 15 years for cypress, white pine and redwood tanks. This was unfair to the timbers mentioned as the short life obtained was undoubtedly due to poor selection of timber, poor construction, the tank not being kept filled with water or some one or more of a number of faults that would cause early decay.

# Cost of Water Main Construction at Pasadena, Cal.

The following table from the report of Water Department of Pasadena for the year ending June 30, 1918, shows the cost per foot of cast iron main construction by fiscal years compared with estimate at present prices:

| | Fiscal year ending June 30 | No. feet laid. | Costs | | | | |
|---|---|---|---|---|---|---|---|
| | | | Labor. | Auto. | Material | Overhead. | Total. |
| 4" class "B"...... | 1914 | 15,713 | $0.222 | $0.012 | $0.487 | $0.059 | $0.780 |
| | 1915 | 27,021 | .241 | .016 | .430 | .063 | .750 |
| | 1916 | 12,453 | .268 | .024 | .457 | .097 | .846 |
| | 1917 | 14,670 | .267 | .015 | .477 | .058 | .817 |
| | 1918 | 11,020 | .298 | .022 | .743 | .107 | 1.170 |
| Average ....... | ... | 80,877 | .254 | .017 | .496 | .073 | .840 |
| Present prices.. | ... | ...... | .340 | .026 | 1.048 | .141 | 1.555 |
| 6" class "B"..... | 1914 | 19,878 | .257 | .017 | .678 | .076 | 1.028 |
| | 1915 | 6,691 | .356 | .031 | .668 | .097 | 1.152 |
| | 1916 | 12,546 | .296 | .022 | .610 | .117 | 1.045 |
| | 1917 | 11,636 | .252 | .015 | .673 | .071 | 1.011 |
| | 1918 | 9,247 | .333 | .029 | 1.120 | .148 | 1.630 |
| Average ....... | ... | 59,998 | .287 | .021 | .730 | .097 | 1.135 |
| Present prices.. | ... | ...... | .377 | .030 | 1.548 | .196 | 2.151 |
| 8" class "B"...... | 1914 | 11,955 | .323 | .018 | 1.042 | .107 | 1.490 |
| | 1915 | 1,622 | .374 | .031 | 1.063 | .135 | 1.603 |
| | 1916 | 2,748 | .478 | .021 | .829 | .171 | 1.499 |
| | 1917 | 7,323 | .419 | .024 | 1.010 | .110 | 1.563 |
| | 1918 | 1,774 | .390 | .027 | 1.617 | .203 | 2.237 |
| Average ....... | ... | 25,422 | .375 | .022 | 1.051 | .123 | 1.571 |
| Present prices.. | ... | ...... | .442 | .032 | 2.208 | .268 | 2.950 |
| 10" class "B"..... | 1914 | 3,541 | .385 | .006 | 1.290 | .123 | 1.804 |
| | 1915 | 1,831 | .422 | .025 | 1.270 | .158 | 1.875 |
| | 1917 | 749 | .494 | .033 | 1.413 | .147 | 2.087 |
| Average ....... | ... | 6,121 | .409 | .016 | 1 299 | .136 | 1.860 |
| Present prices.. | ... | ...... | .604 | .036 | 2.960 | .360 | 3.960 |
| 12" class "B"..... | 1914 | 8,588 | .410 | .024 | 1.600 | .180 | 2.214 |
| | 1917 | 1,674 | .643 | .056 | 1.953 | .195 | 2.847 |
| Average ....... | ... | 10,262 | .448 | .028 | 1.658 | .183 | 2.317 |
| Present prices.. | ... | ...... | .729 | .040 | 3.820 | .459 | 5.048 |
| 14" class "B"..... | 1916 | 1,200 | .568 | .032 | 1.834 | .291 | 2.725 |
| Present prices.. | ... | ...... | .793 | .044 | 4.760 | .560 | 6.157 |
| 20" class "A"..... | 1915 | 3,053 | .781 | .061 | 2.732 | .315 | 3.889 |
| Present prices.. | ... | ...... | .974 | .074 | 6.970 | .802 | 8.820 |
| 24" class "B"..... | 1917 | 2,266 | 1.870 | .251 | 5.742 | .594 | 8.457 |
| Present prices.. | ... | ...... | 2.338 | .304 | 10.830 | 1.347 | 14.819 |

All unit prices include removal and replacement of street pavement.

**Cost of Chemicals for Water Treatment at Council Bluffs, Ia.**—The average cost of chemicals for water treatment at Council Bluffs, Ia., in 1917 was $4.16 per 1,000,000 gal. tested, according to the last annual report of Jos. B. Thornell, Chemist of the Purification plant. The total pumpage was 1,186,870,000 gal.; 256,800 lb. of alum or 1.5 grains per gal.; 145,750 lb. of hydrated lime or 0.9 grain per gal. and 2,691 lb. of chlorine or 36.3 oz. per 1,000,000 gal. were used. The alum cost $14.25 per 1,000 lb., chlorine 15 ct. per pound and lime $4.85 per 1,000 lb. in January and February, $5.35 from March to August and $6.55 from September to December. The above prices include freight.

**Denver Water Plant Formally Transferred to City.**—The plant of the Denver Union Water Co. was formally transferred to the city and county of Denver, Colo., on Nov. 1. The purchase price was $13,922,836.

# Consolidation of Sludge as a Dewatering Method

Many methods have been employed for dewatering sludge—air drying, drying by heat, fermentation with yeast, filter pressing, and draining on prepared beds. Another solution of this problem is suggested by Mr. Arthur J. Martin, M. Inst. C. E., in the Oct. 25 issue of The Surveyor. His solution was developed from observations made in connection with the septic tank laid down at Belleisle, Exeter, in 1896. In this tank the sludge was purposely left to accumulate for several years, and by December, 1900, it had reached a depth of about 4 ft. Samples were then taken from the top, the middle and the bottom of the deposit. These samples showed a water content of 88.8, 83.9 and 80 per cent, respectively, the percentage of water diminishing progressively from the surface to the bottom. Mr. Martin stated that there can be little doubt that the comparative dryness of the lower portion of the sludge was due to the squeezing out of the water by the weight of the superincumbent mass, each particle of which exercised on those below a partial pressure due to the difference between its own weight and that of the liquid which it displaced.

The observation above recorded has been confirmed by experience at several other works. A large proportion of the suspended matter which many tank effluents contain is derived from the sludge banked near the outlets, portions of which are periodically lifted to the surface by the gas generated therein. With a view to obtaining a tank effluent as free as possible from suspended matter, Mr. Martin has been in the habit of laying at the outlet ends of the floors of his tanks a pipe, having a slot extending the whole width of the tank, through which the sludge under the outlets for effluent might be forced out by the pressure of the sewage. Where these slotted pipes were regularly used, they worked freely, and the floors near the outlets were kept comparatively clean; but where, as not infrequently happened, they were neglected, the sludge accumulated, and often became so dense that when the valves were opened to draw it off, it would not budge.

At Andover there were three tanks side by side, the cleansing pipes from all three being led into a valve chamber by the side of one of the outermost. These pipes were left for some considerable time unused. When at last the valves were opened, the sludge from the nearest tank flowed freely, but that from the others, which had several yards of pipe to pass through, absolutely refused to move. At length, by dint of rodding, the pipes were freed, and the sludge began to come out very slowly in a dense cylindrical core. The percentage of moisture was unfortunately not noted, but it was undoubtedly very low. At Andover, as at Exeter, the sludge was old and well mineralized, the loss on ignition in the latter case ranging from 27 to 31 per cent of the dried solid. It would not as a rule be convenient to keep the sludge in the tanks so long, and a fresher sludge might not consolidate quite so readily, but any sludge which will settle at all must be heavier than water, and will therefore exert a partial pressure which, though small in a shallow layer, will in a deep column be very considerable.

These observations suggest that an appreciable proportion of the water contained in sludge may be best and most economically removed by running or pumping the sludge into a shaft of the necessary height, provided at the base with doors through which the compacted material may be forced out by the weight of the superincumbent mass. After a few days in such a shaft, the lower portion of any ordinary sludge should have parted with enough of its water to be readily handled with a spade. If for any reason it is desired to dry it still further, a platform for the purpose may be arranged at the base of the shaft.

The use of heat at this stage will probably not be economical, better results being obtained by blowing air through the sludge, whereby the process of air drying may be greatly accelerated.

Mr. Martin concludes that while it is practically certain that the sludge obtained by any of the older processes can readily be reduced to a manageable condition by its own pressure, it is not so clear that this method will be applicable to activated sludge. Such a sludge is notoriously flocculent and contains a very large percentage of water.

# Improvement of a Hydrogen Sulphide Water by Aeration and Lime Treatment

A sanitarium water supply, objectionable by reason of its hydrogen sulphide content and high hardness, was made palatable at a trifling cost by aeration. The experiment was carried out by the Bureau of Sanitary Engineering of the California Board of Health and is described by Mr. C. G. Gillespie, Director of the Bureau, in the Monthly Bulletin of the Board.

The supply is obtained from a 110-ft. drilled well. It is pumped at the well through several hundred feet of galvanized and cast-iron pipe to a 5,000-gal. tank. From this point the water is again pumped to a 15,000-gal. tank on a hill back of the sanitarium. This latter tank serves as the distributing and pressure reservoir for the institution. Galvanized pipe is used as the distributing system.

Chemical examination of the water directly from the well showed a low organic content, but highly mineralized with 20.0 parts per million of hyrogen sulphide present. The mineral analysis figured to hypothetical combination gave the following results:

| | |
|---|---|
| Calcium carbonate ($CaCO_3$) | 110 |
| Magnesium carbonate ($MgCO_3$) | [illegible] |
| Sodium sulphate ($Na_2SO_4$) | [illegible] |
| Sodium chloride ($NaCl$) | 248 |
| Iron | 0 |
| $H_2S$ | 20 |

Magnesium carbonate, sodium sulphate and sodium chloride are the predominating salts in the water. Hydrogen sulphide ($H_2S$) is also present in large quantity and would make this water unpalatable and highly discolored due to the action of the hydrogen sulphide on the water pipe.

Samples taken at different parts of the system showed a gradual increase of iron from zero at the well to 0.6 parts per million at the tap in the hospital. Zinc was also present in a sample taken at the hospital. The presence of both iron and zinc in the water indicated that the hydrogen sulphide was attacking the pipe line. Inspection of a portion of the galvanized pipe showed the zinc coating practically dissolved off.

The precipitated iron and sulphur in the water imparted a very distinct color and turbidity to the supply and made the water repellent to those who had to drink it. The extreme hardness of the water was also objected to on account of the difficulty in obtaining a lather with soap. Laboratory experiments were made to remove both of these objectionable features.

Aeration proved to be satisfactory in the removal of the disagreeable hydrogen sulphide odor, while the addition of 4 lb. of 90 per cent lime, after removal of the hydrogen sulphide, gave a water low in hardness and agreeable to the senses. As the present water supply has not yet been decided upon as a permanent supply, no recommendations were made to soften the water. To remove the objectionable odor, however, an overhead splash platform with cascade effect was recommended and subsequently built at both tanks. After a week's operation with this aerating device, tests were made to determine its effectiveness in removing the hydrogen sulphide. The results were as follows:

| | $H_2S$. | Iron. | Odor |
|---|---|---|---|
| Water at pump | 20.0 | 0.0 | Very strong $H_2S$. |
| Inlet to upper tank (after first aeration) | 2.7 | 0.2 | Distinct $H_2S$. |
| Tap in sanitarium (after second aeration) | 0.0 | 0.2 | No odor. |

**Industrial Power Plants Save 3,500,000 Tons of Coal.**—Industrial power plants which have adopted the conservation recommendations of the Fuel Administration are estimated to have saved 3,500,000 tons of coal in the past 6 months. Some plants reported a coal saving as high as 25 per cent, while the average saving was reported as from 10 to 15 per cent.

# Advantages and Disadvantages of the Storage of Water[*]

By MELVILLE C. WHIPPLE.

**Purification by Sedimentation.**—When running water is arrested in its flow the force of gravity immediately exerts a greater influence toward purification. The term "purification" is used here to include the removal of any substances which detract from wholesome or attractive properties. Gravity tends to carry downward the suspended particles. A lake, pond or artificial reservoir is a large sedimentation basin and in it are precipitated injurious substances. The amount of material brought to the basin is often very large, as in the case of streams which carry much clay. The Ashokan Reservoir in the Catskills receives in floodtime the water of streams which run red with clay material, and yet the water discharged at the gate-house contains only a trace of the amount found at the head of the reservoir. Larger particles settle more rapidly than small ones. Microscopical bodies like the bacteria settle slowly, but in the presence of larger particles many of them are carried down. The longer the water is retained the greater will be the efficiency of sedimentation. In bodies of water like the Great Lakes, where long storage exists, there remains no visible trace of all the suspended matter that enters. In large bodies of water there are disturbing influences which combat sedimentation. Wind and wave action in shallow depths carries to the surface material already precipitated, but this action is spasmodic and the net effect registers a great improvement.

**Reduction of Color.**—Decolorization is another process which goes on with advantage in stored waters. A great reduction in the color of such waters occurs after storage for several weeks or months. In the Hobbs Brook Reservoir, supplying a portion of Cambridge water, the color at the upper end averaged 75 on the platinum scale during 1916, while that at the lower end averaged 18. In the Wachusett Reservoir of the Metropolitan system the reduction was from 36 to 17. Various causes contribute to this improvement. At the surface the bleaching action of sunlight causes a decomposition of the coloring matter. Experiments have shown a reduction of about 50 per cent in a month. Below a depth of 5 ft. the action is not appreciable owing to exclusion of light. Oxidation by beneficent forms of bacteria also plays a role; but the greatest factor of all is probably due to a neutralization of electric charges carried by the color particles. This results in their coming together to form particles large enough to settle out. The last phenomenon is as yet imperfectly understood. The total effect of all the forces operating to bring about decolorization is that water which was unattractive to sight and taste undergoes such an improvement in quality as to be available for use.

**Equalizing Effect on Quality of Water.**—Another factor operating strongly for purification in large basins is the equalizing effect on the quality of the water. This involves no other action than that of simple mixing. Analyses, both chemical and bacteriological, of the water entering reservoirs will show that the quality varies at different times, sometimes in a striking degree. If it was not for this fact there could be no equalization of quality; but inasmuch as the water is sometimes worse than others, if a long period of storage is provided there is a mixing of good and bad water which smooths down fluctuations in the quality of the incoming streams. The effect is the same as dilution. Equalization is of special significance when taken in connection with the hygienic or bacterial quality of water. It is undoubtedly true that the germs of water-borne diseases, such as typhoid, cholera and dysentery, are not uniformly present at all times even in sewage-polluted waters where the colon bacillus of the intestine is constantly found. Attempts to isolate the typhus bacillus, for instance, are not always successful when heavily polluted waters are examined. Infection of water, then, occurs with fluctuations in intensity. This being so, it is easy to see that there is much greater danger from the epidemiological standpoint of supplying to a filter, or directly to a city, a polluted water which has not been stored. A heavy dose of infective material may be encountered at intervals when it is not expected, if storage is not made use of.

**Destruction of Bacteria.**—It used to be thought that the only factor operating during storage to remove bacteria was that of sedimentation. We now know that by far the greater action is due to certain "devitalizing" processes now going on naturally, which result in the final extermination of disease-producing microbes. In temperate climates the typhoid bacillus is more often the cause of water-borne epidemics than any other organism, and for this reason it has been the subject of many lines of research study. Much is now known concerning its length of life in water, the effect of temperature upon the rate of destruction and various other matters. The researches of Dr. A. C. Houston, of the London Metropolitan Water Board, have probably been the most exhaustive along these lines and likewise as well received as any. The question of the influence of storage upon the quality of water has long been an important one to the city of London, as most of its water is derived from the Thames and other polluted rivers, the water being stored in large basins for a period of about 15 days and then filtered.

Very complete tests were also made by Dr. Houston to determine the effect of temperature upon the death of typhoid bacilli in water. His findings were directly opposed to some of the earlier work but are now generally accepted. They indicate that temperature is an important factor and that the vitality of the bacillus persists longer with lowering temperature.

The results indicate that the life of the typhoid bacillus is longer in the cold months of winter and early spring. At this time any dejecta from patients, if it is thrown on the ground, has its best chance of reaching the consumer. Cold weather protects the bacteria and the melting snows and rain hurry them along on their journey. On the other hand, the greatest number of typhoid cases occur in the late summer and fall. At that time the stream flow is less and the temperature is nearer the average for the year, or possibly higher, and so the typhoid microbes have a precarious time. Other forms of bacteria, except some common soil and water forms, are also found to decrease rapidly in stored water, but the disease bacteria and strictly body forms, like bacillus coli, show a greater rate of decrease. It is apparent from the work of Houston and others that storage provides a great protective barrier for the consumer against the germs of water-borne diseases. The use of small basins is an aid in this direction, although several weeks' storage is necessary to the absolute destruction of disease-producing bacteria.

**Disadvantage of Storage.**—Among the disadvantages of storage is one that arises in connection with color. In all ponds and large bodies of water there are three zones marked by differences in temperature. Assuming a depth of 50 to 100 ft., we find from April to October in the upper 15 to 25 ft. water of uniform temperature which is in active circulation both horizontally and vertically. Below this for perhaps 15 ft. is a zone where the temperature drops rapidly, sometimes 10° in a foot. The movement of water is in the opposite direction to the zone above. Finally below this middle, or transition zone, is one where there is almost no movement of water. This is the only portion of a reservoir which may be said to afford stagnant water. Everywhere else the water is in circulation. If it is necessary to use water from this zone it will be found to have a color considerably higher than the surface, and this color may temporarily increase upon exposure to air. It is due to soluble organic matter in combination with iron which has been taken up from the slime and soil at the bottom. When the iron becomes oxidized upon exposure to the air it settles out and carries much of the color with it. To a considerable degree this trouble may be obviated, for a few years at least, by removing all the vegetation, roots and mucky soil from the land which is to be covered with water. The procedure is expensive, costing over $2,000,000 for the Wachusett Reservoir. When the Ashokan Reservoir was built subsequently the benefits were not deemed commensurate with the cost, and no soil stripping was done, although roots were grubbed out near the flow line of the reservoir. Experience to date with this reservoir has justified the procedure.

**Dangers from Stored Waters.**—Aside from the trouble caused by growths, which after all are "minor horrors," there are at times positive dangers from stored waters. When we divide the capacity of a lake, pond or reservoir by the amount of water taken from it each day a figure is obtained which represents the nominal period of retention in that basin. It is not correct to assume from this that all the water entering is confined for that period. Mixing is not as thorough and complete as this, except in shallow basins. I have already mentioned the zone of colder, quiet water which lies at the bottom from about April to October. There is a similar although less pronounced condition in the cold winter months, when the bottom layer is slightly warmer than the top. Water which enters a reservoir stratified in this manner does not mix well with the quiet water but tends to flow over it. The period of storage is thus shortened and the time for purification lessened by that amount. Polluted water entering the basin reaches the outlet sooner than it would if the temperature was uniform from top to bottom. Mixing would then be more thoroughly accomplished. The general shape of the shore line and the location of the outlet sometimes afford another element of danger, and give rise to "short circuits." There may be a direct line of flow from the inlet to the outlet which does make use of the total storage available by reason of bays and coves where the water does not mix. The ideal arrangement is one which makes use of projecting portions of a shore line to cause the water flowing through the basin to pursue an irregular course. The effect is the same as interposing baffles in a small basin. Mixing is much more complete. A direct line of flow may be necessary with regular shore lines and also prove perfectly satisfactory under usual conditions. It may not afford protection under unusual conditions. A high wind for several hours or days may blow straight toward the outlet and set up a rapid movement of the water in that direction, or a sudden freshet in the spring may bring in a lot of warm water. It has been observed many times that this warm water does not mix readily with the cold water already in the basin because it is not as dense. Instead it spreads out in a sheet over the top of it. If this incoming water carries with it the microbes, say, of typhoid fever, little time is given in the reservoir for their destruction, and they may persist in the water leaving the reservoir. The combination of freshet, wind and pollution may break down the protective barrier of any storage basin.

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[*] From paper presented before the School of Public Health, Boston.

**Conclusions.**—In conclusion it may be fairly said that the storage of surface water affords a very effectual means for safeguarding their hygienic quality. The dangers arising from the use of impounded water supplies come from inability to make use of a proper period of storage under some unusual conditions, and not from the failure of the natural processes of purification to be carried on. The use of stored waters is also attended by certain disadvantages, chiefly a temporary increase of color, and the production of tastes and odors from the growth of microscopic organisms. These are overcome in large measure if artificial means of purification are later employed, such as filtration. The benefits and advantages which accrue from storage, on the other hand, are numerous and pronounced in their effect. Most important of these is the reduction in the numbers of nearly all forms of bacteria, and especially of those forms found normally or occasionally in the human and animal body. Water is not a favorable environment for the existence of any of these. Research has shown that the disease-producing bacteria, like the typhoid bacillus, succumbs in a very few weeks at the longest. Storage also improves the physical properties of water by allowing the precipitation of sediment and the removal of coloring matter, changes which render it more attractive for human consumption. The equalizing effect of large storage basins is likewise of great importance.

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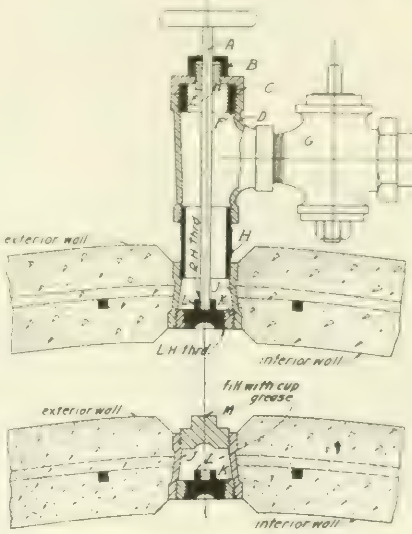
**War Emergency and Reconstruction Conference.**—A war emergency and reconstruction conference will be held at Atlantic City, N. J., Dec. 4, 5 and 6, under the auspices of the Chamber of Commerce of the United States. The meeting will bring together from 2,000 to 3,000 industrial leaders to discuss problems that have arisen with the war.

# Service Connections to Concrete Water Mains

A simple method of making service connections to reinforced concrete distribution mains is described in a recent bulletin, "Concrete in Architecture and Engineering," published by the Portland Cement Association. In making the connection regular stock pipe fittings are used. No tapping machine is required and for that reason excavation need be carried only to the top of the main. In the accompanying sketch A is a steel stem; B, brass packing nut; C, malleable iron cap; D, malleable iron tee; E, close nipple; F, malleable iron bushing; faced, I. S. Thr'd L. H., O. S. Thr'd R. H.; G, cock; H, nipple; J, malleable iron coupling; K, plug, bronze; L, malleable iron bushing; faced, I. S. Thr'd L. H., O. S. Thr'd R. H., and M, malleable iron plug. After plug "L" is raised to and screwed into faced bushing "F," stem "A" is unscrewed and cap "B" with close nipple "E." Packing nut "B" and perforated cap "C" are removed and a solid cap screwed on faced bushing "F."



Sketch Showing Service Connection for Reinforced Concrete Pressure Pipe.

## Increasing Flow of Well by Dynamiting

Dynamite was used for increasing the flow of a well at the plant of the Sacks Manufacturing Co. at Woodstock, Va. The well, sunk to a depth of 240 ft. through hard limestone, produced only 30,000 gal. of water in 24 hours. The rock strata were very tight and almost without crevices, so it was decided that shooting would be necessary to obtain satisfactory results. The charge used was 325 lb. of 60 per cent straight nitroglycerin dynamite. The charges were packed tightly in 4-in. metal tubes (ordinary rain pipe), each section 10 ft. long. The first tube rested on the bottom of the well, the others being placed one on top of the preceding one until the explosives extended up the bore hole to within 60 ft. of the surface. In the top tube (the last one put down), a deep well exploder was imbedded in one of the sticks of dynamite. Connecting wire long enough to reach to the top of the well was attached to this exploder and the connecting wire in turn attached to the leading wire which at the proper time was attached to the poles of the blasting machine. Each of the tin tubes had a tight bottom soldered on it. A bail wire was run through two holes in the top of the tube and a hook attached to a ⅜-in. rope was then hooked into the bail and used in lowering the tubes. The rope and tube were left attached to the last charge lowered (the one containing the exploder). The object of this was to permit pulling this tube up to the surface again and examining it if, for any reason, the charge failed to go off. The shot produced the desired increase in water. In a test over a period of two days and one night continuous pumping, they were unable to exhaust the flow and the water in the well lowered only 6 ft., showing standing water to a depth of 180 ft.

## Cost of Sewer Construction at Providence, R. I. in 1917

The following table from the last annual report of M. H. Bronsdon, City Engineer, shows the average depth of cut, nature of excavation, and contract cost of labor per foot, on the different sizes of regular sewers built during 1917 for the city of Providence, R. I.:

| Items. | Average nature of excavation | Av. depth of cut. feet. | Av. cost per foot. |
|---|---|---|---|
| 6-in. pipe in drains to curb line | Sand, dry | 10.50 | $0.97 |
| 6-in. pipe in drains to curb line | Sand and gravel, dry | 10.50 | 1.19 |
| 6-in. pipe in drains to curb line | Hardpan | 10.50 | .50 |
| 6-in. pipe in drains to curb line | Rock | 10.50 | 1.88 |
| 6-in. pipe in drains to curb line | Filling | 10.50 | .70 |
| 8-in. pipe in basin connections | Sand, dry | 8.00 | .50 |
| 8-in. pipe in basin connections | Sand and gravel, dry | 8.00 | .53 |
| 8-in. pipe in basin connections | Hardpan | 8.00 | .40 |
| 8-in. pipe in basin connections | Rock | 8.00 | .75 |
| 8-in. pipe in basin connections | Filling | 8.00 | .50 |
| 8-in. pipe in sewer | Sand, dry | 11.67 | 1.25 |
| 8-in. pipe in sewer | Sand and gravel, dry | 11.67 | 1.75 |
| 12-in. pipe in sewer | Sand, dry | 12.00 | 1.27 |
| 12-in. pipe in sewer | Sand and gravel, dry | 12.00 | 1.49 |
| 12-in. pipe in sewer | Sand, gravel & b'lders | 12.00 | 2.50 |
| 12-in. pipe in sewer | Hardpan | 12.00 | 1.48 |
| 12-in. pipe in sewer | Rock | 12.00 | 2.40 |
| 15-in. pipe in sewer | Sand, dry | 12.25 | 1.06 |
| 15-in. pipe in sewer | Sand and gravel, dry | 12.25 | 1.90 |
| 15-in. pipe in sewer | Sand and gravel, wet | 12.25 | 3.00 |
| 15-in. pipe in sewer | Hardpan | 12.25 | 1.00 |
| 15-in. pipe in sewer | Rock | 12.25 | 1.00 |
| 16-in. circular brick sewer | Sand, wet | 19.00 | 6.75 |
| 20-in. circular brick sewer | Sand, wet | 19.00 | 2.00 |
| 24-in. circular brick sewer | Sand and gravel, dry | 13.00 | 3.20 |
| Average cost of building manholes, each | | | $19.66 |
| Average cost of building catch basins, each | | | 16.26 |
| Average cost of building extra inlets, each | | | 3.27 |

The cost for rock excavation is generally included in price bid per lineal foot of sewer, otherwise it is paid for at $4 per cubic yard.

## Standards for Water Purity

In a paper presented recently before the School of Public Health, Boston, Mass., Mr. H. W. Clark, Director and Chemist, Division of Water Laboratories, Massachusetts State Department of Health, points out that while many standards for estimating the bacterial purity of water have been made, on the whole, judging the subject from 30 years' experience and practice, none of them appears to fit all cases. Many waters entirely unfit for domestic consumption because of organic pollution would pass any bacterial standard. Many critics state that the chemical analysis of water has no sanitary significance, the bacterial analysis alone being of value. Laboratory examinations of water supplies are made to answer at least two main purposes, however: first, a medical or health purpose to answer the question—Is this safe water? that is, will it or will it not cause or be likely to cause disease to its users? This the bacterial examination will, within certain limits, show. Bacterial examination will not show the organic pollution past or present; this can be shown only by chemical analysis.

The first main reason for water examination, then, is the medical or health reason. The second reason can be called, speaking broadly, the chemical or sanitary engineering reason. This engineering desire for certain information in regard to quality of a water can be answered only by chemical analysis. The medical cry is—Is the water safe? The engineering demand besides this is—Is this water suitable? It is to answer this question that control of water supplies by chemical analysis is made.

Massachusetts is a state small in area, but with a population of 3,500,000 people. It has the lowest typhoid death rate of any state in the Union and this rate is constantly decreasing. It long ago passed beyond the point where it asks simply—Is this water supply safe?—and demands, Is this water of good quality in all respects? Is it satisfactory and the best that under all circumstances can be supplied to this city or that town? If not the best, how can it be improved? By a combination of all control methods—legislative, sanitary engineering in construction and inspection, adequate prevention of entering pollution where possible, sand filtration or disinfection where such entrance cannot be prevented but must be overcome, and by bacterial and chemical laboratory work, public water supplies can always be made safe and satisfactory.

## Cost of Irrigation Pumping in Chandler District of Salt River Project

The following data on irrigation pumping are given by James M. Gaylord, Electrical Engineer, U. S. Reclamation Service, in an article in the October Reclamation Record:

In the Chandler district of the Salt River Project of the U. S. Reclamation Service six batteries of wells were built in 1909-1913, each battery consisting of three 16-in. wells, 25 ft. apart, cased with double telescoping casing ⅛ in. thick. The wells are connected through suction pipes to a 12-in. vertical centrifugal pump mounted on a steel framework in a 9-ft. cylindrical caisson extending to a depth of 40 to 50 ft. below the surface of the ground. The drilling record of a typical well is as follows:

| | Feet. |
|---|---|
| Yellow clay | 20 |
| Sandy clay | 20 |
| Water and quicksand | 40 |
| Yellow clay | 10 |
| Good water gravel and boulders | 2 |
| Sandy clay | 50 |
| Water and quicksand | 16 |
| Water gravel and boulders | 37 |
| Yellow clay | 22 |
| Water and gravel boulders | 28 |
| Yellow clay | 10 |
| Water gravel | 29 |
| Cement, gravel, some water | 16 |
| Total depth | 300 |

Perforated casing from 90 to 92, 158 to 195, 217 to 245, 255 to 300 ft. below ground surface.

The average results from this district were as follows:

| | |
|---|---|
| Total feet drilled in district | 4,435 |
| Cost per foot of well | $7.60 |
| Production per battery, sec. ft | 10 |
| Construction cost per battery | $18,700 |
| Plant efficiency, per cent | 62 |
| Lift, feet | 46 |
| Cost of power, per k.w.hr | $0.007 |
| Operation cost, 1913-14, per acre-foot lift, 1 foot, 1.8 ct. | |

**Drainage System of Protection Against Electrolysis.**—In a paper presented before the Associated Engineering Societies of St. Louis, Mr. D. W. Roper, Superintendent Street Department Commonwealth Edison Co., Chicago, stated that the Edison Co. had kept a careful record of the cost of repairing burnouts caused by electrolysis for over 10 years and the results show that with the underground cables having a book value of about $15,000,000, the cost of repairing damage due to electrolysis is about $1,000 per year. The drainage system of protection has been used by the Edison Co., from the first. The other utilities in Chicago using underground cable have also adopted the drainage system which satisfactory results, but the exact figures are not available.

**Some Regulations for Feeding Community Garbage to Swine.**—The State Board of Health of Iowa has adopted the following regulations regarding the disposal of garbage by feeding to swine: Feeding station shall be located on land with proper drainage, preferably on high, rolling land. Premises must be equipped with sanitary feeding platforms with an ample supply of water for flushing the same, and must have an ample supply of water so that every vehicle and all containers used in the transportation of garbage can be thoroughly washed after use. All unused garbage must be disposed of in a sanitary manner. Any contract with a town or city shall provide, on behalf of the municipality, that the garbage shall be separated from the refuse at the initial point of receiving by the housewife or other handlers and only the garbage as is fit for feeding shall be delivered to the feeding station.

## Fire Service Connection for Industrial Plants

The accompanying illustration shows the arrangement approved by the Department of Health and Sanitation of the U. S. Shipping Board for dual connections at shipyards. The connections consist of two check valves, three pressure gages and two blow-offs. It is installed in a manhole of ample size for convenient operation provided with a drain to carry away water blown off during tests. The specifications for the check valves require the seat ring, disc, holding ring and screws, disc stud, arm hinge pin and bushings to be of bronze; disc to be faced with medium hard rubber, and that liberal clearances shall be left around clapper and arm in full positions.

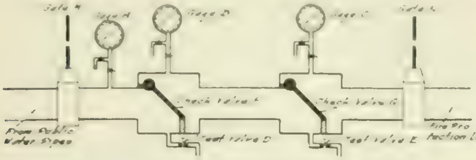


Diagram Showing Arrangement of Valves.

The operation of the connection is shown in the diagrammatic illustration. Normally, indicator post gate valves M and N are open and test valves D and E are closed. At monthly intervals a test should be made of the tightness of the check valves, and at intervals of about three months the bonnets of the check valves should be removed and the checks and their bearing seats carefully cleaned. To facilitate removal of bonnets, manilla paper packing, soaked in machine oil, should be used and bolts greased with heavy oil and graphite. To make test of tightness of check valves, close valve M and open valve D. Pressure on gage A should fall to zero and on gage B hold. Valve E should now be opened and pressure on gage B should fall to zero and on gage C hold. After test is completed valves M and N must be left open to permit flow through the connection.

## Practical Rules for Burning Coal in the Power Plant

The following suggestions for boiler room operators are based on many years' experience of the combustion engineers of the Westinghouse Electric & Manufacturing Co.:

Give your fireman an opportunity to acquire the fundamental principles of fuel burning.

If you have a difficult fuel problem, consult a combustion engineer.

Prevent smoke by proper firing methods.

Use gages to indicate exactly the condition of fire bed at all times. As a minimum these gages should consist of a draft gage indicating draft in furnace above fuel bed, a draft gage indicating draft at boiler side of flue damper, and a steam-flow meter for individual boilers.

$CO_2$ is the principal product of complete combustion of coal. From 10 to 12 per cent $CO_2$ should be obtained in flue gases to insure minimum fuel loss.

Avoid loss due to unburned coal in the ash.

If you are wasting exhaust steam, you are wasting coal.

Do not permit grates to clog. A systematic method of keeping the air spaces clean must be followed.

Inspect the baffles in boilers, as broken or leaky baffles raise the flue-gas temperature and waste coal.

Avoid leaking in of cold air around boiler setting.

Install stokers. Hand firing is rapidly being recognized as an obsolete and wasteful method of firing.

Clean scale from tubes, as every particle of scale wastes coal.

Avoid soot formation. All boiler tubes should be blown externally once every 8 hours when in continuous service.

All smoke flues should be as short and straight as possible. Flues should also be made air-tight, and all joints and connections should be well fitted, calked and riveted. Use asbestos gaskets on clean-out doors.

Place flue dampers in front of boiler so that firemen will adjust them as required. Dampers placed in rear of boilers are seldom disturbed, regardless of their condition.

The size of coal has much to do with the capacity and efficiency of boilers. In general the air pressure penetrates the fuel bed formed by coarse coal more easily than that formed by finer coal, resulting in disturbance of best furnace conditions.

Keep the heating surfaces of the boilers free from soot, scale or oil.

Keep the fires level and free from holes.

Do not carry the fires so thin as to draw a lot of excess air through.

Do not carry the fires so thick as to have incomplete combustion of the coal.

Do not soak the coal with water before firing.

Be sure the blow-off valves do not leak.

Do not have the safety valve popping off continually.

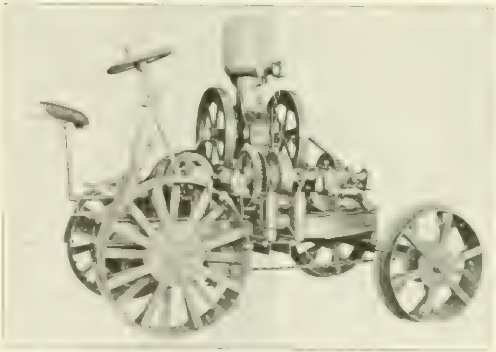
Cover steam pipes.

Do not waste steam through leaky valves or traps.

Never use live steam if exhaust steam is available and can be used as well.

## New P. & H. Backfiller of Dragline Type

A backfiller of the dragline excavator type has recently been placed on the market by Pawling & Harnischfeger Co., Milwaukee, Wis. The machine is designed to backfill all trenches ordinarily cut with trench excavators for water, gas or sewers. The general dimensions of the backfiller are: Out to out of rear wheel, 5 ft.; wheel base, 6 ft. The weight in working order is about 4,000 lb., and the propelling speed is approximately 1½ miles per hour. A scraper, 4 ft. wide, of Fresno type, is furnished with the machine. The car body is built up of two 6-in. channels running fore and aft and cross-connected by means of 6-in. channels where necessary. The machinery base, consisting of two 6-in. channels, is mounted on top of these beams and efficiently connected to them. The main machinery consists of one intermediate shaft, chain connected to the engine, and one drum shaft, gear connected to the intermediate shaft. The drum runs loose upon the shaft and is connected thereto by means of a cone clutch 13-in. diameter by 2-in. face, lined with asbestos lining. The drum is 7-in. diameter for ⅜-in. steel rope. The intermediate shaft is connected to the engine by means of a high-speed roller chain of 1-in. pitch. A cone clutch is provided on the intermediate shaft enabling all machinery to be placed out of action. A steel bevel pinion on the end of the intermediate shaft is provided with two semi-steel bevel gears on the propelling shaft. These gears are provided with clutches, by means of which propelling motion is obtained in either direction. The steering machinery is mounted under the car body and is operated by a worm and worm wheel, which is self-locking. Connection between this shaft and the front axle is by means of chains. The steering shaft is hand operated, a large hand wheel, with



The "Tom Thumb" Backfiller.

handle being provided for this purpose. The operating levers are located at the rear of the machine and so grouped that they can all be reached from one position. The machine is driven by a 6-HP., single cylinder vertical, hopper-cooled engine, running at 450 revolutions per minute, and connected to the machinery by means of a high-speed roller chain.

The trade name of this latest addition to the excavating equipment line of Pawling & Harnischfeger is the "Tom Thumb." As indicated by the name the new machine is smaller than the well-known P. & H. boom type backfiller.

# The Control of Small Sewage Disposal Works

Some interesting notes on English practice in sewage works control were given by Mr. James H. Edmondson, Chemist and Manager of the Southall-Norwood Sewage Disposal Works, in a paper presented at the annual meeting of the Instition of Municipal Engineers of Great Britain. An abstract of the paper follows:

In the control of small works, as in large ones, efficiency in combination with economy is the goal to be aimed for. The author has frequently seen when visiting sewage works that the effluents leaving small works are infintely better than those leaving larger ones—in fact, in the author's opinion, many of the effluents are too good, if such can be the case, and consequently economy must have suffered to attain this high degree of purity. This probably arises through insufficient knowledge of the sewage treated and effluent obtained, and consequently the sewage has been put through more processes or treated on a larger area than is really necessary to produce a satisfactory and stable effluent. If, however, systematic records, not necessarily of a highly technical character, were kept, they would be of great assistance in determining any further treatment, and also satisfy those responsible of the results obtained day by day.

**Records.**—The quantity of sewage delivered at the disposal works is of the first importance. This is fairly simple to determine on a small works without going to the expense of fixing a recorder. Good approximate results can be obtained by the use of a rectangular weir or V-notch, and recording the depth flowing over same every hour or half-hour. The effluent can also be recorded by fixing a rectangular weir at the outfall from each channel or main channel from the filters, as at the Southall works.

The quantity of tank effluent each bed, filter or plot of land treats can often be approximately estimated by recording the number of hours each unit works per day, providing a practical test has been previously carried out of the quantity each unit treats per hour. In cases where pumping is necessary, the time the pumps are at work usually gives a true record of the flow, any appreciable increase being due either to loss of efficiency of the pumps or increase in flow.

The measurement of the sludge at the time of cleaning the tanks—which is easily accomplished—along with the number of days such tank has been at work, is of considerable value. Any appreciable increase may be due to increase of flow, which should be accounted for above or increased strength of sewage. On the other hand, should there be an increased flow of sewage delivered at the works whilst the production of sludge is normal, of course eliminating storm water, it will probably be found to be due to subsoil water leaking into the sewers or some other sudden discharge into the sewers.

These, with many others, which are particularly adapted to individual works, are common-sense records. There are in addition, however, a fe wchemical and physical tests which can easily be applied, and in conjunction with the above records will enable one to have a small works under control.

**Analyses.**—The results given are usually expressed in parts per 100,000, and even then some of the figures are small decimals, which can hardly be arrived at by simple or rough-and-ready methods. There are methods, however, which approximate to one or two of the tests if not the figures. One of the principal tests which can be so approximated is the 4-hours' oxygen absorption test. This is carried out by placing a known quantity of the sample under examination in a standard solution of acidified potassium permanganate (containing available oxygen) which will oxidise any organic matter present. As is well known potassium permanganate solution has a brilliant purple color, which gradually disappears with the loss of its available oxygen, being colorless when all the oxygen has been absorbed. Upon this characteristic a simple test has been devised. A few other tests are described below:

Oxygen Absorbed.—Apparatus and chemicals required: One pair of Apothecary's scales, one or two weights totaling 0.4 gramme, one litre graduated flask, 10 cc., 25 cc. and 100 cc. graduated cylinders, pure sulphuric acid, potassium permanganate, and a stock (6-8 oz.) of stoppered bottles.

Solution.—Weigh out on the scales 0.4 gramme of potassium permanganate, and place in litre graduated flask, and dissolve in a little good tap water; add 100 cc. of sulphuric acid and allow to cool. When cool, make up to the litre mark with water.

Method.—Place in a stoppered bottle 100 cc. of sample to be examined and add 10 cc. of the acidified solution of potassium permanganate. Note how long it takes for the color to entirely disappear. With crude sewage this may occur in a few minutes; with a good effluent it may take some hours.

Presence of Nitrates in the Effluent.—Apparatus and chemicals required: One Nessler tube, a solution of 1 per cent brucine sulphate tube and 2½ cc. of brucine solution, thoroughly mix and add 2½ cc. of strong sulphuric acid down the side of the tube, which will settle at the bottom. If a pink zone forms, gradually changing to amber, nitrates are present—the more marked the reaction the more nitrate present.

Turbidity.—Apparatus required: Piece of white cardboard with black lines ruled across, a ground bottom Nessler tube at least 6 in. in height and 1 in. in diameter, graduated up the side. Shake the sample thoroughly and slowly pour into the Nessler tube, which is placed on the paper, until the black lines are obscured. A satisfactory effluent should show a depth of 4 or more inches.

Odor and Stability.—Apparatus and chemical required: Stoppered bottles and a solution of methylene blue. A good effluent should have no offensive odor at the time of sampling or even after being kept in a stoppered bottle in absence of air for 4 to 6 days at a temperature of 80° F. The stability can be estimated by tinting the sample in the bottle with about six drops of methylene blue solution before placing on one side or in an incubator. Examine the sample daily, and should the color persist until the fourth day one can be satisfied of the stability of the sample. If an effluent has a deficiency of dissolved oxygen and nitrates it is invariably found that it is charged with an excess of organic matter, and consequently will be found to be unstable, emitting a disagreeable odor, and discoloring methylene blue upon incubation. If the color persists for four days it is usual to record it on the record sheet with a + sign; if it disappears within four days, with a — sign.

The following is a typical method of recording the recults:

| Date. | Oxygen absorbed. | Nitrates. | Turbidity. | Odor. | + Stability. | Approx. quantity treated. | Rainfall. | Max. | Min. |
|---|---|---|---|---|---|---|---|---|---|
| Sept. 2. | 6 hrs. | Strong | 4½″ | Earthy | + | — | Nil | 90 | 58 |
| Sept. 3. | 3 hrs. | Slight | 3″ | Stagnant | — | — | Nil | 98 | 60 |

While advising that such records and elementary tests would prove of great assistance in the control of small works, and which can easily be carried out by any intelligent workman, the author would certainly recommend that periodical samples be submitted to an analyst and his report compared with the results obtained on the works. By such means the manipulator could fix his own limitations to the elementary tets just described.

In conclusion it may be mentioned that in considering an analyst's report the following four tests are usually taken as standards:

1. The 4-Hours' Oxygen Absorption Test.—A permissible

effluent should absorb less than 1.40 parts per 100,000; a good effluent under 1.0 part.

2. The Albuminoid Ammonia Test.—A permissible effluent should contain less than 0.15 part per 100,000, a good effluent less than 0.10 part.

3. Suspended Solids.—The Royal Commission recommends that a final effluent should contain less than 30 parts per 100,000.

4. Dissolved Oxygen Test (oxygen absorbed from tap water in five days at 65° F.).—The Royal Commission recommends that a final effluent should not absorb more than 20 parts of oxygen per 100,000.

# Operating Results of Reinsch-Wurl Screens at Rochester, N. Y.

Operating results of the recently completed main sewage disposal plant of Rochester, N. Y., were outlined by Mr. E. A. Fisher, Acting City Engineer, and Mr. N. A. Brown, Special Assistant on Sewage Disposal, in a paper presented at the recent convention of the American Society for Municipal Improvements. The following notes are abstracted from his paper.

The plant consists of coarse racks, detritus tanks, Riensch-Wurl screens, Imhoff tanks, sludge-drying beds and power plant.

**Results with Reinsch-Wurl Screens.**—The original installation of screens consisted of four Reinsch-Wurl screens 12 ft. in diameter, at an inclination of 30° with the horizontal. Two had openings ⅜ in. by 2 in., so cut as to give 43 per cent opening. These were installed to operate on the dry weather flow preceding the Imhoff tanks. Two had openings 1/16 by 2 in. with 18.8 per cent of opening. These were so located as to permit the effluent to be turned into the Imhoff tanks, or by-passed to the plant effluent.

The removal on ⅜-in., by 2-in. openings was found to be so low that one of these has been replaced by plates having ⅛-in. by 2-in. openings, giving 32.6 per cent openings, which gives a more satisfactory removal of the floating material, such as matches, peas, kernels of corn, etc., which passed through the ⅜-in. openings and had to be removed by skimming from the Imhoff tanks.

From Jan. 1 to Sept. 1, 1918, the amount of screenings removed was 1,856 cu. yd. from a sewage flow of 7,786,300,000 gal., or a removal of 6.44 cu. ft. per 1,000,000 gal.

The amount of screenings is variable, depending on size of openings, velocity through screen plate and the density of the sewage. The variable amount is shown by the following table:

| Time elapsed. Days. | Mesh. In. | Rainfall In. | Cu. ft. screenings per 1,000,000 gal. |
|---|---|---|---|
| 6 | ⅜ | .92 | 2.00 |
| 3 | ⅜ | None | 1.02 |
| 6 | ⅛ | None | 3.03 |
| 5 | ⅛ | .18 | 2.62 |
| 6 | 1/16 | None | 3.80 |
| 3 | 1/16 | 1.06 | 6.47 |

The amount of loss of head is affected by the suspended matter in sewage. In time of rain a heavy mat on the screen increases the loss of head.

Based upon the observation of a number of days, the following curve was determined for flows up to 35 m.g.d. on the 1/16-in. mesh screen:

$Y = .01\ (2.9\ X + .71)$. In which

$Y$ = loss of head in feet; $X$ = rate of flow in m.g.d.

For the ⅛-in. screen, with $X$ varying from 24 to 40 m.g.d., the equation is $Y = .025\ (X + 1)$.

**Grit Removal.**—The amount of grit removed from a flow of 7,786,000,000 gal. was 509.2 cu. yd., or 1.76 cu. ft. per 1,000,000 gal. This quantity varies from .95 cu. ft. per 1,000,000 gal. in January to 4.05 cu. ft. per 1,000,000 gal. in March. This is exclusive of the two grit chambers at river siphons.

**Imhoff Tanks.**—On May 8 the quantity of sludge in the tanks was 13,400 cu. yd. Between May 8th and Sept. 2 there was drawn 9,890 cu. yd. of wet sludge. Then there remained in the tanks 7,680 cu. yd. There was therefore deposited in the tanks, from May 8 to Sept. 2, 4,170 cu. yd. The flow through the tanks in this time was 2,051,700,000 gal. Sludge accumulated at the rate of [illegible] cu. yd. per 1,000,000 gal. The temperature affects the volume of sludge in the tanks so these figures are indefinite.

Sludge is drawn onto the beds to a depth of 9 in. Under the most favorable weather conditions it becomes spadable in 6 days. Throughout the season the average drying period would be 11 days. The moisture content of the sludge when drawn averages 81 to 83 per cent and when removed from the beds has been reduced to 57 to 63 per cent.

The total sludge drawn this season up to Sept. 1 was 11,385 cu. yd. of wet sludge. In drying this volume shrinks about one-third or 9 in. of wet sludge reduces to 6 in. in thickness.

## Sludge Disposal at Providence, R. I.

The cost of sludge disposal from the sewage treatment works of Providence, R. I., for 1917, was $7.10 per ton of dry solids, according to the report of M. H. Bronsdon, City Engineer, for that year. The sludge is pressed and the cake carried away on scows. The sludge is pumped by Shone ejectors (two 500-gal.) to storage reservoirs; thence by gravity to forcing receivers (four, 8 ft. diam. x 12 ft. long), thence forced under 60 lb. pressure per square inch, up into the presses. The ejectors and forcing receivers are run by air pressure generated by one 150 and one 50-HP. compressor, actuated by electric motors. Filter presses are used, each with from 43 to 54 plates with 6 in. center holes, forming cake 36 in. square and from 1¼ to ¾ in. thick between filter cloths which surround the plates. Further details from the city engineer's report follow:

Amount of sludge produced, 8,717 million gallons.
Gallons of sludge produced per million gallons of sewage treated, 879.
Pounds of lime added per thousand gallons of sludge, 109.2.
Per cent of solids in wet sludge, 10.28.
Amount of sludge pressed, 6,370 million gallons.
Amount of water removed by sedimentation of sludge in reservoirs, 2,061 million gallons, or 23.6 per cent.
Tons of sludge cake produced, 15,067.
Tons of sludge cake produced per day, 41.28.
Per cent of solids in pressed cake, 25.0.
Tons of solids produced per day, 10.3.

## Irrigation Pump Geared to Automobile Engine

A unique installation used on some small pumping projects is mentioned by Mr. James M. Gaylord, Electrical Engineer, U. S. Reclamation Service, in an article in the October Reclamation Record. The installation consists of a centrifugal pump direct connected or geared to an automobile engine and controlled by means of automobile control mounted in a convenient position. Where such installations are made, the automobile engine is usually operated at a comparatively low speed in order to insure longer life of the equipment. The continuous service required of a pumping plant would, in a few months, amount to the equivalent of many thousands of miles operation of an automobile and it is necessary to operate such installations at slow speed in order to secure long life.

**Appraisal of Utica, N. Y., Water Company.**—The property of the Consolidated Water Co. of Utica, N. Y., is valued at $8,670,000, according to the recently submitted report of Metcalf & Eddy, Consulting Engineers, Boston, Mass., who made the appraisal for the company. The following schedule is a summary of the appraised value:

| | |
|---|---|
| [illegible] supply mains, purification and pumping system, properties, distribution reservoirs and appurtenances, dis[illegible] works structures, buildings, etc. | $5,315,000 |
| [illegible] | [illegible] |
| Water power and diversion rights, including compensation agreements | 2,300,000 |
| Going concern value, organization and incorporation expense | 525,000 |
| Working capital, material and supplies | 160,000 |
| Total | $8,670,000 |

## News Letter

### St. Louis Items.

C. F. Nagel moved his team outfit on an Illinois River job near Ottawa, Ill.

P. J. Murphy has a steam-shovel at work unloading coal for the Wabash R. R. at Moberly, Mo.

The Cedar Rapids Const. Co. are busy with several nice concrete jobs on the M., K. & T. R. R.

J. L. Keller, Sun City, Kansas, will have his 18 team, machine and fresno outfit idle in a few days.

G. W. Galegor has taken a piece of Cook-O'Brien Const. Co.'s work on the Burlington R. R. at Farley, Mo.

Frank Gorman, the hustling powder man, looked natural when we met him in Kansas City the other day.

G. E. McMahon, 2100 Market St., St. Louis, Mo., has 15 teams idle. Wants some grading in this neighborhood.

John West, son of A. L. West, died of influenza at Butler, Mo., on Oct. 28th. His body was buried in Kansas City.

J. C. Kaiser is scouting around for a grading job. Reports his team outfit at McClure, Ill., will be idle in a few weeks.

Keating Bros. are straightening curves for the Chicago & Illinois Midland R. R. near Auburn, Ill. Doing this force account.

Wm. Dankleff of Mt. Olive, Ill., is grading passing track extensions for the Wabash R. R. at Brisbane, Cerregordo, Tolona and Sidney, Ill.

Dan. C. Crane, Springfield, Mo., has 900 yd. of solid and 1,500 yd. of loose rock on the Frisco R. R., 75 miles west of St. Louis, to sublet.

B. F. Brooks has moved his team outfit from Allerton, Ia., to Waldron, Mo., on a piece of Cook-O'Brien Const. Co.'s work on the Burlington R. R.

Tom Campbell is laid up with influenza at his home in Topeka, but we hope to be able to report in next issue that he is back on his job at Chilooko, Okla.

C. B. McNamara Co., 280 W. Seventeenth St., Dubuque, Iowa, have a small steam-shovel idle that they would like to place on some job or will lease same.

Contractors when in want of labor or work for their outfits write Koenig Labor Agency, 612 Walnut St., St. Louis, Mo., or 503 Delaware St., Kansas City, Mo.

Tom Campbell died of influenza at his home in Topeka, Kansas, on Nov. 9th. At the time of his death Tom was working at Chilooko, Okla. Only sick a few days.

Wm. P. McCadden, son of P. J. McCadden, died here on Oct. 10th after a very short illness in his 36th year. The remains were shipped to Memphis for interment.

Cooper & Sons have started work at Beverly, Mo., and Ralph Dutcher is moving his outfit to Farley, Mo., on the Cook-O'Brien Const. Co.'s Burlington contract.

F. T. Sullivan of the Walsh Construction Co. passed through St. Louis the other day on his way to Cricket, Ark., to resume work on the Missouri Pacific R. R. at that point.

Frank L. Aymond is about through with his bridge job near Poplar Bluff, Mo. Aymond has 4 cracker jack pile driving outfits idle. R. R. No. 4, Poplar Bluff, Mo., will catch him.

W. A. Ross of M. Ross & Son enlisted with Uncle Sam last week. Is going in to the tanks and treat the Huns rough. Ross & Son finished their highway contracts near Kansas City.

R. T. Amis has one of his team outfits at work at Winfield, Kansas, on the Santa Fe R. R. under Cook & O'Brien. Also another outfit on A. Moore Const. Co.'s work near Augusta, Kansas.

Mulvill Bros., Alton, Ill., were awarded 16 miles of second track work by the C. & A. R. R. between Reinker & Nilwood, Ill. This is principally all light scraper work. Will sublet this in quantities to suit outfits.

Geo. M. Gross writes us from Hortonville, Wis., that he had just completed his large concrete road job there and would like to secure some similar work south. Has three fully equipped concrete paving outfits, also a 20 team outfit idle.

Chas. Eby, one of the best known contractors in this part of the country, died suddenly at Garnett, Kan., on Nov. 5th with a stroke of paralysis. His body was taken to Pana, Ill., for burial. At the time of his death Mr. Eby was building a reservoir for the city of Garnett.

F. G. Jonah, formerly chief engineer of Frisco Railroad, who left here as major with the Twelfth Engineers, a St. Louis regiment, has just been promoted to lieutenant-colonel and assigned to the Division of Light Railways and Roads in the American Expeditionary Forces in France.

Columbus S. Jones, the boss stationman, has subbed thirty miles of bank widening on the Texas Pacific R. R. near New Orleans, La., from A. L. Cook. Will begin work immediately. Has also subbed another job of bank widening from A. L. Cook on the M., K. & T. R. R. from Bartlesville to Oklahoma City.

J. W. McMurray Contracting Co., Kansas City, Mo., were awarded two splendid concrete jobs in Texas by the Santa Fe R. R. They also closed a contract with the Katy for similar work at Huntsdale, Mo. In addition to these jobs they have several more outfits at work in Kansas and Oklahoma for the M. K. & T. R. R.

The Terminal Railroad Association in East St. Louis has let a contract for the erection of a two story concrete coal hopper and a terminal on its property near the Relay Depot. The cost will be $127,000. It is expected that work will be started on the coal hopper immediately, which will be followed by the construction of the terminal.

The C. R. Cummins Co., Cleveland, Ohio, was awarded contract for building a 10 mile cut off for the Toledo & Ohio Central Railway between Pleasantville and Eckers, Ohio. In addition to this they are building a large yard at Zeigler, Ill. Also a yard for the Pennsylvania R. R. at Terre Haute, Ind. Have another big job from the Pennsylvania at Columbus, Ohio. Finishing 60 miles of second track work for the Pennsylvania R. R. between Toledo and Columbus, Ohio. A yard at Yellow Creek, Ohio, for the Pennsylvania R. R., and a third track between Hammondsville and Yellow Creek, Ohio.

The W. M. Sutherland Building and Contracting Co. of St. Louis was awarded contracts for the erection of additional cantonments at Fort Leavenworth, Kas., to accommodate 16,000 men. Dispatches from Washington announced that work will begin at once and will represent an estimated cost of $5,000,000. The contracts have been let on the basis of cost plus a percentage of profit. William F. Wilkins, general superintendent of cantonments for 5,000 engineer troops, now under construction at Fort Leavenworth, will be in charge. When all the buildings are completed the fort will accommodate 22,000 men.

A. B. KOENIG.

## Personals

**James W. Costello** of Philadelphia, Pa., has been appointed supervisor of street cleaning and garbage removal for the city of Newark, N. J.

**F. K. Martin**, superintendent of the Humboldt, Sask., electric and water works systems, has resigned and has been succeeded by C. A. Cutting of Saskatoon.

**Carl Brown**, manager of the electric plant at Cedartown, Ga., has accepted a position as manager of the Huntsville, Ala., operations of the Alabama Power Co.

**James S. Dunwoody**, chief of the filtration plant of Erie, Pa., has been commissioned a first lieutenant in the construction division of the Quartermaster's Department, U. S. Army.

**E. V. Leverett** of Conway, Ark., has entered upon his duties as conservation engineer, by appointment of H. C. Couch, United States fuel administrator and director of conservation for Arkansas.

**Frank B. Steele** of Dayton, Ohio, has been appointed associate general manager of the Utica Gas & Electric Co., Utica, N. Y., to succeed W. A. Buttrick, who recently resigned to enter the motor transport service.

**Cornelius M. Cary** has been appointed acting superintendent of the Bureau of Ashes and Garbage of Binghamton, N. Y., to succeed Superintendent M. Edmund Turk, who has been granted a leave of absence for the period of the war.

**William H. Gould** of Toledo, O., has been appointed to an engineering position in the Government Bureau of Industrial Hygiene. Mr. Gould is the founder of the Lucas County Department of Sanitary Engineering and was the county sanitary engineer for several years.

**Thomas N. Hooper**, vice-president of the Davenport Water Co., Davenport, Ia., has been eleced president to succeed the late F. H. Griggs. Mr. Hooper has been with the Davenport Water Company since 1873, coming here as chief engineer. At different times he has been superintendent, general manager and vice-president.

**D. G. Thomas**, an official of the Denver Union Water Co., Denver, Colo., for nearly thirty years and an expert in the science of water supply purification, has resigned as the company's chief engineer and will soon enter private practice as a consulting engineer. He will be succeeded by Acting Chief Engineer Burton Lowther, who came to Denver three months ago from Kansas City, where he was water plant manager for ten years.

**The Oklahoma Utilities Association** has been formed by the merging of the Oklahoma Gas, Electric and Street Railways Association and the Oklahoma Public Utilities Bureau. The officers are: President, J. F. Owens, general manager Oklahoma Gas & Electric Co., Oklahoma City; first vice-president, C. S. Thompson, manager Shawnee Gas & Electric Co., Shawnee; second vice-president, J. W. Shartel, manager Oklahoma Railways Co., Oklahoma City; treasurer, William Mee, president Security National Bank, Oklahoma City; secretary, H. A. Lane, 611 State National Bank building, Oklahoma City; assistant secretary, Prof. F. G. Tappan, University of Oklahoma, Norman. The first annual meeting of the new organization will be held Feb. 13, 14 and 15 in Oklahoma City.

**V. Bernard Siems** has been appointed principal assistant engineer of the Water Department of Baltimore, Md. Mr. Siems is a technical graduate and started the practice of engineering in 1908 with J. G. White & Co., of New York, on the work of reconstructing and electrification of the Maryland electric railways. He entered the employ of the City of Baltimore in 1909 when new improvements to the water system had started and was with the municipality from that time to July 16, 1918, having been assistant engineer, filtration division, and pitometer engineer, engineering and construction division. On July 16, 1918, he was granted leave of absence to assist the construction division of the War Department on the design and construction of water works at Camp Meade, Md.

## Obituaries

**James P. McKay** of the Leadite Co., Philadelphia, died Oct. 24 from pneumonia.

**Frank W. Hutchinson**, a contractor of Nashville, Tenn., died Oct. 29, aged 34.

**Francis R. Crispen**, secretary and director of the Traylor Engineering & Manufacturing Co. and the Traylor Shipbuilding Co. died recently.

**J. R. Sheely**, a member of the firm of Rowler & Sheely, bridge contractors, died Nov. 3 at his home in Fort Collins, Colo., following a stroke of paralysis. He was 70 years old.

**William K. Shelly**, vice-president and general manager of the Tiffin Wagon Co., Tiffin, O., died Nov. 3, aged 74 years. Mr. Shelly was born in Washington, Ill. His boyhood was spent at Peoria, Ill., where he first embarked in business. He came to Tiffin in 1888 as general manager of the America Strawboard Co. After leaving this business he spent several years in Chicago and New York, returning to Tiffin in 1899, at which time he organized the Tiffin Wagon Co.

**Chester Peter Siems**, chairman of the Siems-Carey Railway & Canal Co., and head of allied concerns, which have undertaken many large railroad and canal construction enterprises in this and other countries, including China, died Oct. 23 at his home in New York City after a brief illness. He was born in St. Paul, Minn., and was in his 34th year. On his graduation from Yale in 1907 Mr. Siems entered the engineering department of the Spokane, Portland & Seattle R. R. The following year, with his father and brother, he organized the firm of Siems & Co., which executed a number of railroad contracts in the Northwest. When this firm was succeeded in 1911 by the Siems-Carey Co., Mr. Siems was made president and treasurer. Under his personal direction two allied companies were established for railroad construction in the United States and Canada. The China Corporation also was launched for the purpose of engaging in business abroad. In 1916 the Siems-Carey Railway & Canal Co. was formed by Siems & Carey and the American International Corporation to undertake large railway and canal projects. This company soon concluded a contract with the Chinese government for the construction of 2,000 miles of railway in China.

*Railways and Gov't. Works Issue*

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The *articles* in the first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering and contracting field. The *articles* in the first and last issues of each month (1st and 4th Wednesdays) completely cover country engineering and highway engineering and contracting. The *articles* in the third and last issues of each month (3rd and 4th Wednesdays) completely cover steam and electric railway location, design and construction. See the "mast head" on the first page of the Weekly News Section for information about our weekly contract news.

**Roads and Streets—1st Wednesday**
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies

**Waterworks and Hydraulics—2nd Wednesday**
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power

**Railways and Govt. Works—3rd Wednesday**
(a) Excavation and Dredging
(b) Rivers and Canals
(c) Harbors and Docks
(d) Railway Construction

**Buildings and Structures—4th Wednesday**
(a) Buildings
(b) Bridges
(c) Ship Construction
(d) Miscellaneous Structures

Volume L. CHICAGO, ILL., NOVEMBER 20, 1918. Number 21

# Great Appropriations Should Now Be Made for Public Works

The War Industries Board has removed practically all restrictions as to public works and new construction of all kinds. While this alone insures that 1919 will be an exceedingly active year in the civil engineering and contracting field, it should not be assumed that engineers are thus freed from the duty of vigorously campaigning for large public works appropriations.

Without doubt the construction of merchant ships will continue for some time on a fairly large scale, also many of our soldiers will remain in Europe for months, but there can not be the slightest doubt that a very large part of our present war contract work will soon come to an end and that our soldiers will begin to return home within a few weeks. The release of millions of men from war industries and from the army and navy will not be automatically followed by their immediate employment unless large appropriations for public works are made by cities, counties, states and Federal government.

It would be economic folly to continue the building of such a vast merchant marine as was planned when it was expected that submarine sinkings would continue on a large scale. A much more judicious expenditure of public funds would be for harbor and river improvement.

It has been urged for many years that the Government should assist in reclaiming the millions of acres of swamp and overflow lands, particularly along the lower Mississippi. The greatest objection to Government appropriations for such projects has been that the Government would thus enrich the owners of the lands at the expense of the public. But there is nothing to prevent the purchase of all overflow and swamp lands by the Government prior to their reclamation. Then after draining and protecting these lands from floods, they could be sold at a handsome profit.

There are endless opportunities for the reclamation of arid lands in America, to say nothing of logged-off lands now unfit for use. The tile drainage of millions of acres of farm lands has been urged as an economic measure by the U. S. Dept. of Agriculture, but farmers have been very slow to act, possibly from lack of capital. It would seem feasible for the Government to undertake this tile drainage of private lands, charging the cost against the owners and giving them 20 or 30 years in which to repay the Government. If this were done on a large scale under the direction of the army engineers, it would give employment next spring to a vast number of men; and it would be an employment that would be profitable to all concerned—the workers, the farmers and the general public.

The other day a Congressman announced his intention of introducing a bill appropriating $100,000,000 for Federal roads. Isn't it time to stop talking about road expenditures in mere millions? With two and a half million miles of roads and 90 per cent of the mileage unsurfaced even with gravel, this country should cease its petty attitude toward road improvement. We have been spending one and a half billion dollars a month for war. If four months' war expenditures were diverted to road work, we should have six billion dollars available. With that sum about one-quarter of our present unimproved road mileage could be given a hard surface over which trucking could be carried on every day of the year. That would be a really worth while achievement, and it is such an achievement as the present emergency demands.

The railway problem calls for an immediate solution so that a comprehensive program of railway improvements and extensions can be undertaken next spring. The Government should [illegible] of the railways beyond the 21 months after peace is signed, or it should require the railway companies to combine into one or two huge companies under which all the benefits of unification would be secured. Then it would be feasible to plan a great program of railway construction and improvement. Among the many things that should be done is the electrification of all railway lines where hydro-electric power can be developed economically. Lack of capital has prevented our railways for the last ten years from making extensive improvements that were sorely needed. Now is the time to secure the capital through the Government, and to expend it so as to effect great reductions in the cost of rail haulage.

Again we urge engineering societies to take an active part in this transition period. There is no body of men better able than engineers to guide the public wisely in the expenditure of public funds.

## Falacious Arguments Against Influenza Masks

In San Francisco the use of gauze masks to ward off the germs of influenza has been made compulsory for all persons on the streets or in public places. Thus far San Francisco has had relatively few influenza cases compared with other large Pacific Coast cities. Consequently the "bug mask" seems likely to prove to be a really great invention. But, as is always the case when any new device appears, there are many men who decry it. Often these objectors are "educated," but seem to be quite lacking in logical education.

The commonest argument against the "flu mask" is that the openings in the mask bear the same relation in size to a microbe as a barn door to a mouse. For example, a doctor recently wrote to a daily paper protesting against the use of these masks, saying:

> If the gauze worn over the face is expected to prevent the entrance of micro-organisms to the respiratory tract it seems that the absurdity would be apparent to those who know that Pfeiffer's bacillus, pneumococci or streptococci, must be magnified many hundreds of times to be visible at all, and that if the ordinary gauze mask be magnified to the same extent it would show the meshes to be so large as to apparently offer no obstruction to the house fly. Such an attempt to mechanically prevent germ invasion might be compared to fencing against fleas in Florida with barbed wire.

All of which sounds very plausible, but is fallacious reasoning. The very same sort of argument was used nearly half a century ago against filtering water to remove typhoid germs. The argument then took this form: "The interstices between the grains of sand in a filter are as large compared with the typhoid bacillus as a house door is to a mouse. If all the doors of a house were open, a mouse could pass from garret to cellar without being stopped. How absurd, then, is the belief that a typhoid germ can be caught while wandering through a layer of sand a foot or two thick."

It seems very "absurd," doesn't it? Yet when an actual count of the germs in a drop of raw water was made, and a similar count was made of the germs in the same water after filtration through a thin bed of sand, it was found that only one germ in a hundred had passed through! "Incredible," but true. Of 100 "mice" that started in at the garret to go downstairs, only one reached the cellar, although every door was open. Now this was no speculation or guess. The microscope, after Dr. Robert Koch's discoveries 40 years ago, could be used to count the microbes in a measured volume of water even as one might count mice in a trap. And the microscope made it certain that, somehow or other, porous filter sand does stop most of the microbes in water.

It is 80 years ago this very year that a British civil engineer, James Simpson, finished at Chelsea, London, the first sand filter plant for a city. It was intended primarily to remove the visible impurities of the Thames water. Little did he or anyone else dream that the real danger in using that water was the invisible living things that inhabited it; for Pasteur had not yet shown that many diseases are caused by microbes, and Koch had not perfected the microscopic detection of germs. Yet it began at once to be noticed that typhoid fever was less prevalent than it had ever been.

Not until about 40 years ago was it fully demonstrated that filtration can be so scientifically conducted, by the aid of microscopic counts of bacteria, as to remove almost all danger of contracting typhoid from drinking water.

Then came another great discovery, namely, that a minute quantity of chlorine is deadly to typhoid germs. One drop of liquid chlorine in two barrels of water is the average dose, but it usually suffices to kill nearly every typhoid germ. When the discovery of chlorination of water was announced, it also was "argued off the floor." Men with no logical training and very little real knowledge of science drew comparisons between the chlorination of water to kill typhoid and the taking of homeopathic medicines to cure diseases. "Consider," they said, "the absurdity of trying to kill the millions of microbes in a barrel of water by merely adding half a drop of liquid chlorine." Yes, it was perfectly absurd, but the microbes all died; perhaps by laughing themselves to death over the absurdity of it.

In drawing an analogy between a flea and a microbe, several elements of difference are usually overlooked. A flea not only is capable of locomotion but can direct his motions by the sense of smell. A microbe, on the other hand, is helplessly and aimlessly carried along by currents of air or water. In the case of microbes that are inhaled, it seems likely that most of them are either attached to particles of dust or to small globules of moisture. In either case, if the mask stops the grain of dust or globule of water the germ itself is caught also.

Relatively few people who have not studied physics are aware that there are several classes of attraction that operate only at very minute distances. Moreover, the laws of attraction at molecular distances are still far from being perfectly understood. For example, it remains a mystery that a diamond will adhere to a greased surface whereas a piece of quartz, or of glass, or of garnet, etc., will not adhere. Upon that difference—even yet unexplained—an inventor in South Africa developed the most effective way of separating the rough diamonds from the "blue earth" in which they are found. But imagine how the wiseacres would have ridiculed his invention prior to seeing it actually "do the trick." There it was, merely an inclined trough whose bottom was greased. Yet when a current of water washed the "blue earth" down the trough, lo, nothing remained behind but the diamonds, plucked out by the magic of the molecular attraction, of the grease! Incredible! Absurd! But a fact.

## Opening the Way for a Great Construction Era

For over four years contractors have been living mainly on the three fair sisters—Faith, Hope and Charity. Construction activities, even before the great war began, were well below normal; they fell off still further when "Got Mit Uns" started through Belgium. A few months later when American plants commenced to get war orders there was some improvement, but the work was confined mainly to the erection of industrial buildings. In the meanwhile material prices had soared to unprecedented heights and labor had become scarce. As a result there was a general slowing up in all kinds of construction. Then our country entered the war. Embargoes and priority orders came into being and drastic regulations were placed on all construction except war projects or work of great economic importance. This was the end. Construction gave a final gasp and went to sleep.

But the time of awakening has come. The War Industries Board last week removed its restrictions. Municipalities can now go ahead with their long deferred improvements; highway building can be resumed; public utilities can make extensions; drainage and irrigation projects can be carried out; in fact the ban has been lifted from all classes of construction except large buildings, for which special permits are still required. At the same time the Board removed limitations on the production of building materials including brick, cement, lime, hollow tile and lumber.

Almost coincident with the removal of the wartime regulations comes the announcement that demobilization of the army is to begin at once. The 1,700,000 soldiers in camps within the United States will be discharged first, 200,000 probably being released within two weeks. When the demobilization is in full effect it is expected to release 30,000 men per week. Thousands of these men thus will be available within a few weeks for labor purposes.

It is, of course, impossible to give any definite estimate of the amount of construction that could be started at once. Practically all public and private improvements have been suspended for nearly two years. There thus has piled up a vast amount of construction, plans for which already have been prepared, and all necessary financing completed.

It is possible, however, to give some idea of the possibilities from Federal Government undertakings. Two instances will be cited. The first relates to the Federal aid highway projects. From January, 1918, to Sept. 30, the payments on Federal aid post roads aggregated $853,000 or less than one-thirtieth of the amount which theoretically could have been paid in that period. In the administration of the Federal aid road act, 691 projects, involving the construction of 7,378 miles, at a total estimated cost of $52,674,000 were approved by the Secretary of Agriculture from July 11, 1916, to Oct. 1, 1918. Only a small percentage of these projects have been completed or placed under construction. There seems to be no reason why the remainder could not be placed under contract in the near future. The other instance is the $1,000,000,000 improvement and equipment program authorized for the railroads for 1918. Of this amount $403,864,000 had been spent up to Oct. 1, and of the expenditure $173,716,000 went for additions and betterments, such as track improvements, machinery, buildings, wharves and terminals, and $216,186,000 for cars and locomotives. Only $13,961,000 was expended for new track. In this one fund there thus is available several hundred million dollars for railway improvements, betterments and extensions.

# A Prophet of 1601

By HALBERT P. GILLETTE.

Note.—In 1601 the British Parliament was importuned by all the river boatmen to legislate against the importation from France of those then novel devices for carrying passengers—stage coaches. Destruction of a great transportation business, [illegible] the ruin of jobs for thousands of "honest toilers" were predicted by Taylor, a poet and a boatman of the Thames, [illegible] capital and labor, and this is what he said:

In 1601.

"Carroaches, coaches, jades and Flanders' mares,
Will rob us of our shares, our fares, our wares.
Against the ground we'll stand and knock our heels,
Whilst all our profits run away on wheels."

Three Centuries Later.

Come, Taylor, back to this big top of Time
That spins the days that let me reel my rhyme.
No longer jades nor mares need worry thee,
Gas motors speed o'er earth and air and sea.
Dead as are you, your direst prophecy.

**Reconstruction Conference of U. S. Chamber of Commerce.**—Many phases of reconstruction will be taken up at the Reconstruction Conference of Industrial War Service Committees called by the Chamber of Commerce of the United States for Dec. 3, 4, 5 and 6 at Atlantic City.

The program for the conference has not been completed, but enough of the details have been worked out to indicate the comprehensive way in which this conference will approach the problem of reconstruction. On Dec. 3, the first day of the conference, the 350 war service committees meeting separately will take up questions of special interest to their own industries. At these meetings there will be formulated the policies of the industries represented by the committees and resolutions which individual crafts desire to present during the conference.

# War Industries' Board Removes Restrictions on Construction

The war industries board on Nov. 12 began to modify the regulations under which it has controlled American industry during the war time. Construction projects are largely released from the war restrictions, while the curtailment of the manufacturing of many articles, including automobiles, is reduced one-half. Under circular issued on Nov. 12 by the priorities division of the War Industries Board, construction projects falling within the following classifications are approved, and no permits or licenses will be required therefor from the non-war construction section hereafter.

1. Construction projects approved in writing by the facilities division of the War Industries Board.

2. All farm and ranch buildings, structures, or improvements.

3. All buildings, structures, roadways, plant facilities, or other construction projects of every nature whatsoever, undertaken by the United States Railroad Administration or by any rail or water transportation company, organization, or utility (whether or not under the direction of such administration), or by the American Railway Express Co., or by the owner or operator of any telegraph or telephone line.

4. The construction, maintenance, improvement or development, by Federal, state or municipal authorities, of highways, roads, boulevards, bridges, streets, parks, and playgrounds.

5. The construction, extension, improvement, maintenance or repair of any public utility, including water supply systems, sewer systems, light and power facilities, and street and interurban railways.

6. The construction, extension, or repairs of all irrigation and drainage projects.

7. Construction projects connected with the extension, expansion, or development of mines or connected with the production and refining of mineral oils and of natural gas.

8. The construction, alterations, or extensions of, or repairs or additions to, plants engaged principally in producing, milling, refining, preserving, refrigerating, or storing foods and feeds.

9. The construction of new, or the alterations or extensions of existing school houses, churches, hospitals, and Federal, state, or municipal buildings, involving a cost not exceeding $25,000.

10. The construction of new buildings not embraced in any of the foregoing classifications, or repairs on buildings involving a cost not exceeding $10,000.

11. The construction of new buildings or structures not embraced in any of the foregoing classifications, or repairs or extension, involving a cost not exceeding $25,000, when approved in writing by the State Council of Defense.

12. Buildings begun prior to Sept. 3, 1918, where a substantial portion of the building has already been constructed.

All limitations on the production of building materials, including brick, cement, lime, hollow tile and lumber, have been removed.

The circular states that the priorities division of the war industries board will, as far as practicable, assist industries in procuring materials, fuel, transportation and labor to enable them to increase their operations to normal limits as rapidly as conditions may warrant. Precedence must, however, be given to stimulate and increase the production of cargo ships and supply the requirements of the army and the navy of the United States as well as to provide for this nation's proper proportion of the enormous volume of materials, equipment and supplies as shall be required for the reconstruction and rehabilitation of the devastated territories of Europe.

Precedence must also be given to such activities as will tend to stimulate the production of foods and feeds, of coal, of natural gas, of oil and its products, of textiles and clothing, and of minerals.

# Labor-Saving Methods and Machines in Limestone Quarrying

A pamphlet describing successful and efficient labor saving methods and machines for limestone quarrying was issued recently by the U. S. Bureau of Mines. The publication, extracts from which are given below, was written by Mr. Oliver Bowles, who visited a number of fluxing limestone quarries for the express purpose of observing labor saving devices.

**Labor Requirements of Various Stripping Methods.**—Loading waste material into dump carts or cars with hand tools is doubtless recognized by most quarrymen as involving the most prodigal use of labor, per ton of material moved, of any method in common use. Fortunately, it is not commonly employed except in very small quarries.

Where the overburden rests on a reasonably smooth rock surface, and the dumping ground is near by, the employment of teams and scrapers results in a pronounced saving of labor over hand methods. Where the waste must be moved a considerable distance a method has been noted whereby the scraper loads are dumped through an opening into wagons on a depressed roadway, the soil being thus handled in two operations. Under such circumstances wheel scrapers are to be preferred, for thus a single operation will suffice, and such simplification reduces the labor requirement.

A drag-line scraper alone has been used effectively where conditions are favorable, and a drag-line scraper used in conjunction with dump cars may be used to advantage. By either method the heaviest burden of the work is accomplished by machinery, and the labor requirement is not high.

The most popular stripping equipment for large quarries is the steam shovel. It requires a small gang of men, and when propery handled and well supplied with cars can load a great mass of material in a day. While the first cost of a steam shovel is high, with proper care the cost of maintenance is not excessive. Where the rock surface is fairly uniform and level the steam shovel is probably the best equipment for loading any considerable thickness of overburden.

A stripping conveyor in conjunction with a steam shovel is sometimes used. Such equipment cannot be generally employed, for it is applicable only to quarries where the overburden may be conveniently disposed in the pit formed by removal of the good rock.

With adequate water supply, proper drainage, and sufficient waste disposal area, hydraulic stripping is probably the most economical of labor of all methods in common use. With two men at the pumping station and two to handle the nozzle, a great mass of debris may be washed down in a single day. The rate of removal depends on the size of the nozzle, the available water pressure, and the consistency of the soil. The rate of progress may be retarded if the overburden is hard, for it may be necessary to bore it with a soil auger and blast with powder. The presence of numerous boulders may also render hydraulic stripping difficult.

As labor is the chief cost item in stripping, the cost per cubic yard is a fair indication of the relative labor requirements of various processes. The following figures represent minimum costs noted by Mr. Bowles during field investigations: Hand shovel and dump cart method, 30 ct. per cubic yard; steam shovel and cars hauled by dinkey engine, 16 ct.; steam shovel and stripping conveyor to above, 3 ct.; drag-line scraper (to loading platform only), 3 ct.; hydraulic stripping, 3 ct.

**The Employment of Blasting Experts.**—If blasting is done by an experienced man of good judgment, subsequent operations may be greatly simplified. If the rock is thoroughly shattered, little labor is required for secondary blasting, and if the rock fragments are thrown down in a way that permits easy handling, loading operations may be performed rapidly and with minimum effort.

A realization of these facts has led some operators to engage the services of blasting experts who are not permanent members of any quarry organization, but who travel about from quarry to quarry as their services are desired. The expert, in accordance with his judgment, developed by long experience, supervises the arrangement and spacing of drill holes, selects the explosive, proportions the charge for each hole, carefully inspects or tests all connections, and fires the charge. The efficiency of the results usually obtained amply justifies the employment of such experts.

**Labor Saving in Rock Loading.**—In many quarries hand-loading has been superseded by the use of power shovels operated by steam, electricity or compressed air. For quarrying fluxing limetone the most obvious advantage in the hand-loading method is the ability of the hand loader to select the desirable and to reject the inferior material. Thus when hand loaded the rock may be hand picked. Where steam shovels are employed such selection is not possible; if siliceous material is shot down with the rock it must be loaded with the rock and separated subsequently by screening or washing.

**Labor Requirement of Hand-loading Method.**—The rock tonnage loaded by hand per man per day varies greatly in different localities. Thus in one of the largest fluxing quarries of the Birmingham district of Alabama the loaders average about 18 tons per man per day, in a Western Pennsylvania quarry they average only 15 tons a day, and in two Eastern Pennsylvania quarries they average 25 and 30 tons, respectively, per day. An average of several quarries, some for the production of limestone for Portland cement and some for the production of limestone flux, is 20 tons per man per day. Thus a quarry producing 1,000 tons of rock per day requires an average of about 50 loaders.

**Labor Requirement of Steam-Shovel Loading Method.**—The labor requirement for steam-shovel work is variable as it depends on the size of the shovel employed and on the conditions under which it operates. In one Eastern Pennsylvania quarry a small tractor shovel with a ¾-yd. dipper requires a maximum of 3 men and it loads a maximum of 400 tons a day. It is claimed by the quarry foreman that it can accomplish as much work as 12 hand loaders, though in ordinary practice it does the work of 7 or 8. A shovel of this type, therefore, saves the labor of 4 or 5 men for an output of 250 to 300 tons per day. In another Pennsylvania quarry it is claimed that two steam shovels employing 10 men in all load as much rock as 45 men by hand methods.

In one Western New Jersey quarry a steam shovel employing 3 shovel men and 4 pit men loads 1,200 tons per day, or an average of 171 tons per man per day. In one Eastern Pennsylvania quarry two steam shovels requiring the services of a total of 16 men load 1,000 tons a day, or an average of only 63 tons per man per day. Figures obtained at various quarries in widely separated localities indicate that an average of about 128 tons of rock per man per day is loaded by the use of steam shovels.

**Labor Saving in Rock Transportation.**—A simple and direct system of transportation is an important factor in designing a new quarry plant. Ease of transportation depends greatly on the situation of the rock ledge. If close to transportation lines and at a high level, conditions are most favorable. A shelf quarry with its floor at a higher level than the crusher or other plant operated in connection with the quarry represents the most favorable condition, for thus transportation may be accomplished by a single operation.

Gravity, when properly utilized, is an effective substitute for power, and it should therefore be utilized for transportation purposes wherever possible. A New Jersey quarry makes such good use of a gravity system that for an average production of 1,200 tons of rock per day, transportation within the quarry requires the services of one man only.

At one New York quarry, the rock is hauled to the crusher in cars by locomotives, all subsequent movements being assisted greatly by gravity. The plant is on a hillside, the crusher, screens, storage bin, and railway line for final haulage being at successively lower levels. Accordingly, the movement of the rock is automatic and requires little or no supervision.

Certain types of equipment tend to conserve labor. By means of a central-control, three-rail electric system now employed in certain large limestone quarries several thousand tons of rock may be delivered from the steam shovel to the crusher daily with the employment of only 2 or 3 men. Aerial tramways and various types of cableways are for the most part automatic and thus require little labor.

**Rehandling of Material.**—A fruitful source of wasted effort is unnecessary rehandling of material. Rock is commonly unloaded and reloaded unnecessarily, or dumped in places that require excessive labor for its subsequent removal. An instance has been observed where a small percentage of a type of rock necessary for plant operation is brought from a distance and mixed with the main supply of rock quarried at the plant. Such rock is carried in hopper-bottom cars, dumped to the bottom of a 40-ft. quarry pit, reloaded by hand into carts, hauled by mules to the foot of an incline, and lifted by cable to the crusher. Such excessive rehandling may be due to lack of equipment or to faulty plant design.

**Size of Crusher.**—The size of the crusher employed has a direct bearing on the labor requirement, not only in the actual crushing operation but also in other branches of quarry work. A prolific source of wasted labor is the employment of a small crusher for rock loaded with a powerful steam-shovel. The attempt is commonly made to substitute steam-shovels for handloading methods, and, at the same time, to retain the small crushers usually employed for reducing rock loaded by hand. Such a combination of a massive loading apparatus with a small crusher has a two-fold effect on the labor requirement.

For steam-shovel loading, large crushers are of distinct advantage in the conservation of labor.

**Type of Crusher.**—Opinion is divided as to the best type of crusher to be employed. Gyratory crushers are popular and are in common use. Single or double roll crushers have the advantage of wide mouths that are not readily obstructed by blocks of stone. A jaw crusher fed by a traveling apron is an effectice labor-saver.

**Devices for Removal of Jammed Blocks.**—The jamming of blocks of stone in a crusher mouth, particularly of a gyratory crusher, is a common occurrence. If adequate facilities for the removal of such blocks are not provided, much time and labor may be wasted. The attempt to loosen blocks of stone jammed in a crusher by using a bar or a sledge may so delay the crusher that other related operations, particularly transportation, may be temporarily suspended. It is wise, therefore, to equip rock-crushing plants with mechanical devices to be used in such emergencies. The use of rope tackle or a pneumatic hoist is common, and either renders efficient service. Where such equipment is available, delays of one-half to three-quarters of an hour that ensued from the employment of old-time methods may be reduced to delays of two to three minutes' duration only.

## Average Loads in Team Hauling on Country Highways

The following observations on hauling by horses on an ordinary country highway, approximately 38 miles in length, were made during the construction of a storage dam at Aziscohos, Me., in 1910.

The best period for hauling was from Dec. 1 to Jan. 15, when sleds could be used. The average load during that period was:

| | |
|---|---|
| Four-horse team | [illegible] |
| Five-horse team | [illegible] |
| Six-horse team | [illegible] |
| Average load per horse | [illegible] |

During the best period of summer hauling the average loads were as follows:

| | |
|---|---|
| Four-horse team | [illegible] |
| Six-horse team | [illegible] |
| Average load per horse | [illegible] |

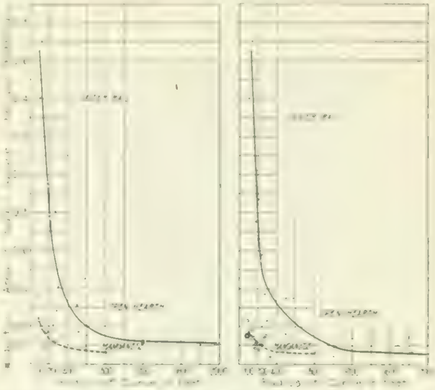
During the most adverse conditions of hauling the average loads were as follows:

| | |
|---|---|
| Four-horse team | [illegible] |
| Five-horse team | [illegible] |
| Six-horse team | [illegible] |
| Average load per horse | [illegible] |

## Relative Life of Manganese and Open Hearth Rail on Curves

Interesting information on the wear of rails on the curves of the Chicago Elevated Railroad is given by Mr. H. W. Roberts, Assistant Engineer of Maintenance of Way, in an article in the Electric Railway Journal, from which the matter following is abstracted.

The curves on which the measurements were taken are all laid with 80-lb. rail, A.S.C.E. section, and are all guarded. The throatway between the running rail and the guard rail is 2 in. on the short-radius curves, and 2¼ in. on curves having radii of more than 500 ft. The elevation of the outer rail is not uniform on the various curves, on account of special conditions which must be met, but in general it will run about as follows: For curves having radii less than 250 ft., 4 in.; 250 ft. to 500 ft., 3 in.; more than 500 ft., 2 in.



Curves Showing Comparative Wear of Open-Hearth and Manganese Steel Rails on Curves.

Original area of head of 80-lb. rail [illegible] sq. in.
Area of head of worn rail [illegible] sq. in.

Fig. 1 shows the comparative wear of open hearth and manganese steel rails on the curves. The unit of wear which is used is the reduction in the area of the head of the rail in square inches per 100,000 cars; and it was so taken in order that the measurements made on the different branches, where the traffic varies widely, might be reduced to the same basis. The total wheelage over each curve was arrived at by taking the traffic for representative days and applying this as a unit over the entire period. There is, undoubtedly, a small error in the totals arrived at in this manner, but the percentage of error is so small that it is negligible.

The maximum wear was found to have been reached when the area of the head of the rail had been reduced by 1.25 sq. in. This was arrived at by taking a number of sections of rail which had been removed from the track, or which was so badly worn that its removal was an immediate necessity.

The equipment at the present time consists of 1,095 motor cars and 575 coaches, the average weight of all equipment being 50,000 lb. per car. The heaviest cars are the steel motors which weigh 69,000 lb., 41,000 lb. on the motor truck and 18,000 lb. on the trailer truck, while the lightest are the coaches, which weigh 33,000 lb.

These cars are all equipped with M.C.B. standard rolled-steel wheels, 34 in. in diameter on the motor trucks and 31 in. in diameter on the trailer trucks. The motor cars are each equipped with two 160-HP. motors, are braked at a high percentage, and are operated in multiple-unit trains of from two to six cars each. The number of coaches per train bears about the same relation to the total number of cars per train as the total number of coaches bears to the total number of cars on the system.

# Drilling and Blasting in Construction of Halifax Ocean Terminals Railway

The railway approach to the Ocean Terminals at Halifax, N. S., commences on the Canadian Government Ry. between Fairview and Rockingham, about 4 miles from the old deep water terminals. The main line of the Halifax Ocean Terminals Ry. will be 5 miles long and double track. In addition there are two yards containing a total of 46 miles of track. Owing to the nature of the rock, which varies from a carbonaceous to a silicious state, badly deformed and full of faults and slips, the magnitude of the work, the fact that all the excavation is inside the city limits, and, owing to the fact that the railway is practically all in excavation, making it possible to work from both ends only, the construction presented many interesting features. Some of these were described by Mr. B. H. Smith, Resident Engineer of the railway, in a paper presented Sept. 13, before the Engineering Institute of Canada. An abstract of Mr. Smith's paper follows:

The rock throughout the work was water bearing to the surface and in some cases drill holes were "flowing wells." This made nearly all the blasting of a submarine nature and eliminated the use of black powder in the through cuts. Owing to the water being so cold, dynamite could not be used even in summer weather, and after experimenting with other grades, 60 per cent low freezing forcite was used.

In widening out in the Point Pleasant Terminal yard, that is, after the water level had been lowered, "coyotes" were driven and black powder used. The drilling and shooting had always to be kept well in advance of the shovels for economical operation.

About 3,200,000 lb. of explosives were used; and 2,250,000 cu. yd. of material have been blasted. Some of the rock, especially in Fairview cutting, had to be blasted several times.

There has been no loss of life or even accident to employes or the public due to explosives and the property damage done is inconsiderable. This is remarkable when the amount of explosive used, the nature of the rock, the number of missed holes in the early stages of the work, all the work being inside the city limits and the difficulty of keeping sightseers off the right-of-way are all taken into consideration. Everything possible was done to insure safety to the public as well as to employes. Before a shot was fired, men were sent around to warn residents. In the case of aged or sick people automobiles were furnished to take them out of the danger zone, and the contractor's doctor looked after the moving of them when necessary. Men were sent out along all streets and roads to keep the people back; the steam shovels and locomotive blew a series of short blasts of their whistles and allowed sufficient time for everyone to get to cover in case spawls should fly. When shooting along the North West Arm, motor boats were used to patrol and keep boaters out of the danger zone.

The plant was for the most part worked continuously day and night in summer and winter.

The Fairview cut, which was opened in September, 1913, proved to be a difficult piece of work. The rock was of slate formation all on edge and water up to the surface. The slate was in very thin layers full of faults and slips, pockets of rotten rock, and had no regular formation. There was an overburden of composite material, including "hardpan," "boulders" and rotten rock. The greatest difficulty was in drilling and shooting. It was found impossible to spring the holes, as the shock of springing caused the holes to cave and they were, of course, lost. Then it was decided to use all 6-in. well drills and place the holes closer together and shoot without springing. A number of spacings were used, but none with satisfactory results. Two coyotes were driven and shot, but they proved a failure. It was almost impossible to drive the coyotes on account of the water. Even with the well drill holes carried down 6 ft. below grade the bottom was full of "bones" which had to be taken up with piston drills and light shots. During this process the holes were loaded as soon as the drilling was completed in order to avoid losing them. There was a lot of trouble with explosives and at one time about 50 per cent of the holes would miss. A surprising amount of powder was dug out by the shovel, some of which was dead, due to the action of the water. The powder that was alive was shot by adding a couple of fresh sticks and a new exploder. After a lot of experiments by explosive company's experts it was found that the cause of the trouble was the action of the water on the exploders. From then on "waterproof exploders" were used and these for a time did away with "misses."

There is a large flow of water in this cut and it would appear that it will always be "wet." When shot, this rock digs easily, as it breaks small. The water seems to be the life of it.

The amount of explosives used to break this rock was 1.7 lb. 60 per cent low freezing forcite per cubic yard. The cost was increased owing to the large amount of casing pipe that had to be used on account of caving holes. Some casings had to be driven to grade.

The drilling in the Quinpool Road cut was done with 6-in. diameter electric "Cyclone" drills and all holes were drilled 6 ft. below grade and not sprung. Excepting the first 500 ft. the rock was fairly easy to drill. There was a varied assortment of rock in this cut, some very soft and some very hard. This made it difficult to judge the amount of explosives to use, as several kinds of rock were encountered in each shot. Some of the pockets of rock were so soft and spongy that the 100-ton steam shovel could almost dig it without shooting.

There was a considerable amount of trouble with the first few shots owing to missed holes. After careful investigation it was found that the exploders were going dead soon after they touched the water. (There was a lot of water in this cut.) The exploders were then dipped in roofing pitch before being used and this eliminated the trouble as all the holes exploded after the exploders were pitched. One hundred holes were shot at a time in four independent series, each series having a separate lead of 220 volt line. Two exploders were put in each hole and each of these connected in a different series. This method reduced the possibility of "misses." The Electric Power Co.'s current was used for all big shots. Batteries have not been used for shooting on any part of the work since May, 1914, excepting for springing and blockholes. The contractors have a power line along the right-of-way from the electric company's powerhouse to Fairview. Immediately before firing a big shot the voltage is tested by the contractor's electrician. When possible to get it, 4-in. "forcite" was used in well drill holes as it is easier to handle. The bottom was well broken and only a few "boxes" were encountered excepting between shots.

The percentage of explosives used was about 1.0 lb. of 60 per cent "forcite" to the cubic yard of rock. Casing pipe was driven through the (overburden) and rotten rock.

Some of the worst work on the line was encountered in Coburg Road section. The cut is 48 ft. deep at the deepest point. The rock is blue in color, hard and full of faults. Owing to the depth it was necessary to take it out in two lifts. Shortly after starting on this cut an injunction restraining the contractors from "shooting in a manner that would throw stones, mud or other missiles on adjoining gardens or houses," was placed upon the work.

It will readily be seen that this injunction proved a drawback to the contractors. While spawls only flew from blasts in a few cases previous to the injunction, they were now liable if a few stray spawls got free even if they did no damage. To try and avoid rock flying, all the holes which were 6-in. diameter were heavily sprung. This had very disastrous results, for while the holes did not cave, the springing opened up the seams and when the main shots were fired, the rock broke so large that it was almost impossible to dig it, and had to be all gone over and plugged.

After the first lift was excavated the shovel moved back and excavated the Quinpool Road cut to grade while this cut was being drilled to grade. Electric cyclones were again used and all holes were drilled 6 ft. below grade. These holes were shot without springing, and while the result was much better than on the first lift there was a great deal of trouble in excavating, the shovel not making more than 50 per cent of its usual yardage. The nature and formation of the rock and the necessity of light blasting owing to the injunction are principally responsible for this.

The drilling on the section from South St. to Bowen Road was all done with 6-in. diameter electric well drills. The holes were drilled 6 ft. below grade and were shot without springing. The amount of overlay varied. In some places there were several feet and in other places none. Steel casing pipe was used through overlay and rotten rock.

Very little trouble was experienced with the shooting of this section, the contractors profiting by their experience on other sections, but there was considerable difficulty with the drilling. When excavating it was found that the rock was fairly well broken, but that the toe on the left (which is the uphill side) broke tight for most of the distance and "toe holes" had to be drilled and shot. The rock was hard and broke large; owing to the dip of the rock some of the shots spilled out to the right or west and lower side, but not seriously.

An average of 1.0 lb. of forcite per cubic yard was used to break this rock.

The cut for the main line and lead tracks gradually increased in width from 40 ft. at subgrade stations 222, to 270 ft. at station 244 and decreases in depth from 60 ft. at 222 to 45 ft. at 244.

In the early part of 1914 one lift 25 feet deep and about 60 ft. wide was drilled and shot. From station 236 west the rock was very hard and broke big, causing a lot of delay to the shovels. After the first lot of shooting was done, it was discovered that more explosives were required and the holes would have to be closer together to break the rock satisfactorily, as a lot of the rock already shot had to be block-holed before the shovel could dig it.

After getting down 25 to 30 ft. in the cut and so drawing off the water, coyotes were driven to slope on the right or south side to get out to width. These were loaded with black powder and gave good results.

The cut was then all cleaned up and made ready for drilling to grade. Six-inch diameter steam cyclone drills started at station 222 and worked east to station 324 and from 234 to Young Ave., steam piston and temple electric drills were used. The holes drilled by steam piston and temple electric drills were 6 ft. below grade and spaced in 6, 7 and 8-ft. squares, dependent upon the nature of the rock. These holes were all sprung and were thoroughly tamped with sand while being sprung to avoid caving. After each spring this tamping had to be pumped out, making the springing process slow and costly. There were also a number of holes lost in springing. The cyclone holes were 6 ft. below grade and were shot without being sprung. The rock in the bottom is harder than on top, but nearly all the rock in the cut is hard and breaks large.

Several methods of drilling have been used. Well drill holes were not sprung, but while piston and temple drill holes were, it was proven that even if the rock will stand springing, it is a mistake to do so, owing to opening up the seams and that the best results are obtained from 6-in. diameter holes shot without being sprung.

Four-inch diameter forcite when available was used in all well drill holes. The rock on the south side breaks to a good uniform slope, but the north side is full of slips and faults and there was some difficulty in getting regular [illegible]

Early in 1916 this cut was widened out to slope on the north side. Coyotes were driven and as the portion of the cut already excavated to grade was shot well below grade these coyotes kept dry. Black powder was used in coyotes with sufficient forcite to explode it. The powder was placed in the coyotes in kegs and these kegs were thoroughly waterproofed with roofing pitch before being used.

This method of shooting gave the best results obtained but as already noted, black powder could not be used in the through cut owing to the water in the rock.

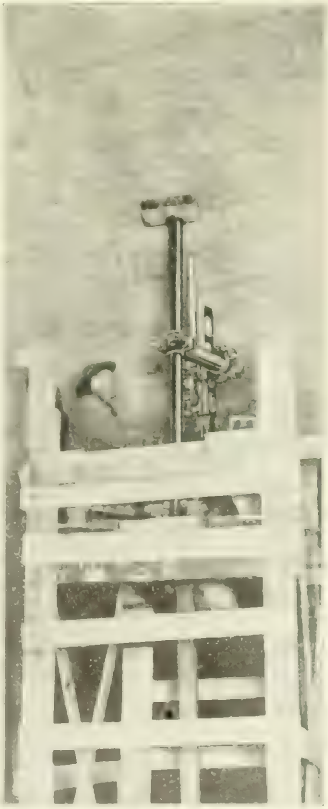
In the early stages of the work at Point Pleasant Terminal yard there was a considerable amount of trouble with drilling and shooting. The bottom was hard to break, but this was overcome. Coyotes were driven widening out on the west side, and these gave very good results, as well as being somewhat cheaper than drilling. The rock in this yard is all shaken and on edge, the formation very irregular, very hard to drill and the explosives lost a lot of power in the seams.

Where the cut is under 30 ft. in 6-in. depth diameter electric "cyclone" drills were used and these holes were drilled 6 ft. below grade and shot without springing. Where the cut was deeper than 30 ft. coyotes were driven. Black powder was used in coyotes and 60 per cent low freezing forcite used in drill holes.

## Drilling Holes in Concrete Roof of Tunnel with Hammer Drill

In the construction of the Dorchester Tunnel, between Broadway Station and Andrew Square, Boston, Mass., the Boston Elevated Ry. Co. made effective use of a hammer drill in drilling 6-in. by ⅝-in. holes in the concrete roof of the tunnel.

The holes are necessary for anchoring the trolley wire blocks. They must be drilled in sets of four and as there is no give in the trolley blocks, which are of maple wood, the holes must be drilled to gauge.



[illegible]

The operator was able to easily drill a hole in 3 or 4 minutes. Some difficulty was experienced by striking iron reinforcement rods which were embedded about 2½ in. deep in the roof of the tunnel and which were struck frequently. However, it was easy to shift the machine by just undoing the two bolts on slide arm and moving 1 in. away from the old hole. A Hummer drill, manufactured by the Chicago Pneumatic Tool Co., was used for this work.

# Methods and Machinery for Sinking Shaft at Seneca Mine

In sinking a shaft at Mohawk, Mich., for the Seneca Mining Co., the progress made established a record for similar work in the Lake Superior District. The methods employed in this work were described by Mr. W. V. Featherly in Engineering & Mining Journal, to which we are indebted for the matter in this article.

The shaft will be vertical to a point 1,450 ft. from the surface. It then follows a 400-ft. radius curve to meet the Kearsarge lode, which drops at an angle of 34° from the horizontal.

The shaft is to be of four compartments, having two skipways, one ladderway and one pipe compartment. Over-all dimensions of the excavation are 11 ft. 4 in. x 21 ft. 4 in. and steel sets of 5-in. H-beam construction are placed at from 6 to 8-ft. centers, depending upon the nature of the ground. These sets are put in so that they are placed 4 ft. from the bottom when the ground is soft, up to 30 ft. from the bottom when the ground is hard. The lagging is of 2-in. hard wood.

A double-drum steam hoist operates two 36-cu. ft. buckets. Air is furnished by one Sullivan tandem-compound, Corliss steam-driven compressor, and one class WB-2 Sullivan straight line, simple steam, two-stage air compressor is installed as a reserve. At the beginning of operations 8 Sullivan DP-33 air tube rotators and 8 hand hammer-drills of another make were in use. It was soon obvious that the Sullivan rotators were securing better results. Four more Sullivan rotators were purchased in April, and since that time 11 have been in constant operation, and two kept as spares. The header, shown in an accompanying cut, is connected to the main air line by a 3-in. hose and is supported in the center of the shaft while drilling by means of a cable leading from the steel framework. There are 11 hose lines, each 14 ft. long and leading from the bottom of the header to the drills; also one connection for a blowpipe.

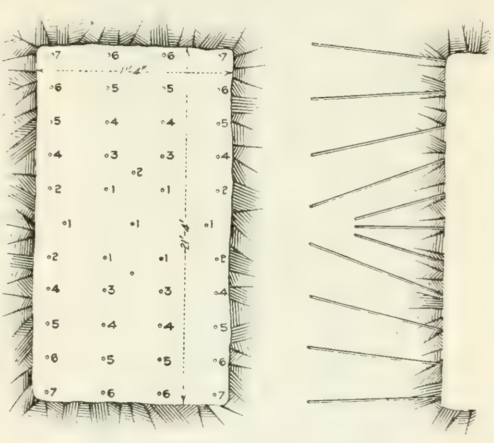


Fig. 1—Order of Blasting at Seneca Shaft.

Excavation was begun on Feb. 13 during severe weather conditions as well as other handicaps. Water froze in the buckets, there were no steam lines installed in the shafthouse, and the rock had to be trammed by hand. Three shifts were worked, with only 4 or 5 men on a shift, and under these conditions progress was slow. During February, 51 ft. was sunk, and in March 113 ft., with conditions about the same. Early in April the rock-disposal haulage outfit was completed, the headframe inclosed, and steam heating coils were installed, so that 154 ft. of shaft was sunk during that month. By increasing wages 50 ct. per day the management was able to secure sufficient men by May 1, and since that time the work has been carried on at full capacity, the crew averaging 10 men and 1 shiftboss per shift, and working 3 shifts.

During May 208 ft. was sunk in 27 working days, and this rate was maintained in June, when 195 ft. was sunk in 25 working days. This figure would have been exceeded had not the men encountered loose, soft ground, which caused considerable delay, as it was necessary to keep the steel work close to the bottom of the shaft to guard against loose rock falling on the men.

**Bonus System for Workmen.**—The bonus system which has been adopted consists of the following: The men receive a flat rate per day up to the first 100 ft. per month; 2 ct. per foot per day for all over 100 ft. up to 150 ft. per month; 3 ct. per foot per day for all over 150 ft. up to 200 ft. per month, and 4 ct. per foot per day for all over 200 ft. per month. This provides an incentive for the men to work hard, and each shift tries to send up more rock than the previous one. The shifts are well organized, and the same men have their regular work to do each time they blast. Two men attend to the raising and lowering of the header, which is hooked on the bottom of one bucket. The drills are taken up in the other bucket. One man looks after the main wires while the others are charging the holes and getting the tools up. The last two men connect the main wires. One of them inspects everything at the last minute and carries the key to the blasting switch.

**Charging and Blasting.**—In blasting, electric igniters and blasting caps are used. The bottom of the deeper holes is charged with 60 per cent powder, 45 per cent being used in the remainder. The average depth of hole is 8 ft., and the round of 45 holes is drilled in from 2½ to 3 hours. The "sink" is made with a double V-cut, and is shot in two separate blasts, the cut holes being fired first. In Fig. 1, cut holes numbered 1, 2, 3 and 4 are shot in that respective order with instantaneous and delay caps. If all of these holes break satisfactorily, the squaring holes numbered 5, 6 and 7 are set off. This plan insures the breaking of the sink holes before the ends of the shaft are squared. Thus far, 2 lb. of explosive per cubic yard of rock has been the average.

Eight construction men are employed in placing sets while the men are drilling and not using the buckets. In drilling, ⅞-in. hollow drill steel is used, and this is sharpened and shanked by machine.

Ventilation is secured by means of a 7½ HP. blower which forces fresh air through a 16-in. Flexoid tube. With this equipment it is possible to return to the bottom of the shaft in less than 10 minutes after blasting. Light is furnished at the bottom of the shaft by two factory domes, with four 100-watt lamps in each dome. The men are required to wear special hard hats, made of felt, treated with resin and shellac, which will resist a severe blow. Movable sollars, made of steel plates and operated by levers, are placed over the two compartments used for loading supplies in buckets. When the bucket hangs at the brace, the lever is thrown and the plates close in around the bucket, making practically a complete cover over the compartment. Electric signals are employed throughout.

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**Zoning System Saving Millions.**—The U. S. Fuel Administration announces that estimates made earlier in the fuel year, that approximately 160,000,000 car miles would be saved in the coal year through the operation of the zone system for the distribution of bituminous coal, are being fully realized. This method of distribution was established so that the coal supply of all sections of the country should normally be derived from mines relatively near, thus preventing abnormal and wasteful transportation movements, and insuring more equal distribution of cars to the mines and the more steady employment of mine labor.

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**Chicago Highway Convention Postponed.**—Due to an important meeting of the War Service Committees of the United States Chamber of Commerce, it has been deemed advisable to postpone the meeting of the American Association of State Highway Officials and the Highway Industries Association to the week of Dec. 9 to 13, the date of the joint meeting to be Dec. 11 and 12.

# The Use of Reinforced Concrete in Marine Works

Mass concrete has been used in the development of harbors for practically as long a time as it has been used on land, but the use of comparatively light concrete structures, reinforced with steel embedded in them, only commenced with the present century and there are few, if any, reinforced concrete marine structures of greater age than 15 years. In that short time, however, it has been used extensively in every continent and in practically every harbor and port of importance. In a paper presented at the Third General Professional meeting of the Engineering Institute of Canada, Mr. A. F. Dyer gave an interesting outline of some of the uses to which reinforced concrete has been put in various harbors. An abstract of the paper follows.

**Reinforced Concrete Piles in Harbor Work.**—One of the first uses made of reinforced concrete was in the manufacture of concrete piles to take the place of timber piles. The first piles made were, as a rule, comparatively small, being not more than 12 in. round or square, and their life in consequence did not prove long.

Reinforced concrete piles are used in English ports, large numbers of 14 in. and 16 in. piles having been used in the improvement works of the port of London since 1911, but the tendency there of late years has been to drive the piles in groups of two, three, four or more piles which are enclosed in reinforced concrete cylinders sunk to a level below dock bottom and filled solid with concrete. These cylinders reach to high water level and support the posts and braces carrying the pier deck.

A jetty built recently at Tilbury Docks, London, is 1000 ft. long by 50 ft. wide and is supported on three longitudinal rows of such cylinder piers. The center row cylinders are 7 ft. 6 in. in diameter containing eight piles while the outer rows are of 5 ft. 6 in. diameter cylinders with four piles in each.

In Senegal, French West Africa, previous to the war nearly 4,000 lin. ft. of reinforced concrete pile wharves were built entirely by the native African labor under the supervision of a few French engineers. The piles used were 13 in. and 16 in. octagonal spaced 13 ft. and 16 ft. apart and carrying a reinforced concrete deck of beam and slab construction. Salt water was used in mixing the concrete for this work, which practice is not one to be recommended in reinforced concrete work.

In a paper read before the Institution of Civil Engineers and published in Vol. 188 of the Proceedings, S. H. Ellis describes the construction of a reinforced concrete wharf 1,160 ft. long by 174 ft. wide at Lower Pootung, Shanghai. The bottom there consists of mud to a depth of over 400 ft., the top 25 ft. of this as a rule forming a fairly solid crust of stiff sandy clay which has to be depended on for carrying loads.

The piles used are 14 in. square driven in groups of four, 15 ft. center to center of groups. The heads of the piles were cut down to a level between low and high water and there capped with a concrete cap and braced with a system of present longitudinal and transverse beams. The pier deck, of reinforced concrete beam and slab construction, is supported on 15 in. square columns resting on the pile caps. Diagonal bracing is introduced between the pile caps and the deck.

The piles were driven by a single acting steam hammer operating a weight of 7,800 lb. dropping 6 in. to 8 in. A final set of 1 in. per blow was usually obtained which was found by tests to have sufficient resistance to carry the designed load of about 25,000 lb. per pile without appreciable settlement. Further driving of the piles into the soft mud below decreased their resistance. The water at Lower Pootung is fresh and after three years no rust, stains nor cracks were visible on the pile heads or super-structure.

At Los Angeles reinforced concrete piles have been used to support a timber floor pier. The piles are 20 in. square at their bases tapering to 14 in. and 17 in. at their tops. They were not driven, but a hole having been jetted into the hard sandy clay bottom the piles were set in the hole base downwards and then consolidated by several blows from a 4500 lb. hammer. As a contrast to this, may be mentioned the practice in New York Harbor, where neither the teredo nor the limnoria is to be found, of using timber piles to support a reinforced concrete deck and structural steel shed.

**Reinforced Concrete Sheet Piles and Cylinder Piers.**—Reinforced concrete sheet piles [illegible] have been extensively used in various ports. Walls built in Madras Harbor consisted of 15 in. and 18 in. square reinforced concrete piles driven by water jet at 8 to 10 ft. centers, depending upon conditions, and anchored back by steel ties. Reinforced concrete slabs varying in thickness from 6 in. to 15 in. were placed at the back of the piles, the lowest slab having a chisel shaped edge and being sunk into the sand bottom. The height of these walls varied from 10 to 16 ft. above dock bottom.

The use of reinforced concrete cylinder piers was first started at San Francisco about 1906 when two shipping piers each 686 ft. long by 130 ft. wide were commenced. The cylinders are 3 ft. 6 in. in diameter spaced 13 ft. 4 in. apart transversely and 15 ft. longitudinally. They were formed by sinking to hard bottom circular wooden forms built strong enough to withstand driving and the water pressure when emptied. All soft mud and water were then removed from inside the forms before they were filled with concrete. Each cylinder is reinforced with eight 1 in. square bars hooped at 9 in. centers with ¾ in. by ⅛ in. bands. The decks are of structural steel I-beams and concrete. Later piers built at San Francisco are of the same type but with all reinforced concrete decks.

At Valparaiso a coaling pier 655 ft. long by 98 ft. wide has been lately completed. This pier is supported on 76 reinforced concrete cylinders, 13 ft. in diameter and varying from 46 to 82 ft. in length. In this case the forms were made of reinforced concrete in sections from 6 ft. 6 in. to 13 ft. high having a shell thickness of 8 in. The bottom section of each cylinder is proved with a cast iron cutting edge and into each section are moulded cast iron jointing rings for the purpose of bolting the sections together. The sections, were built up and bolted together inside a steel tower supported on pile staging and fitted with hydraulic gear so that when sufficient length to come above the water level had been bolted together the cylinder could be lowered to sea bottom. The cylinder was then sunk to the required depth by excavating inside and weighting, further sections being bolted on as it went down. Eight reinforced concrete piles were then driven inside each cylinder after which the cylinders were filled with concrete, the lower portion of which was put in under water to form a seal and the remainder was put in after the water had been pumped out of the cylinder. The heads of the cylinders were then joined by a transverse girder of reinforced concrete cast in place on which rested a deck system of precast beams and slabs.

**Reinforced Concrete Retaining Walls.**—Reinforced concrete retaining walls of different types have been much used. When properly designed these are very suitable in places where stable foundations are not easily obtained and where no great depth of water alongside the wall is desired.

At Lower Pootung, where the deep mud foundations exist, a retaining wall 495 ft. long and with a height of 21 ft. 6 in. above dock bottom was built in the following manner: Cross rows of three 12 in. square piles were driven, the front piles of which serve as king piles to a continuous line of concrete piles which in turn form the face of the wall up to a height of 12 ft. below quay level. At that level the heads of all the piles are connected together by a reinforced concrete supporting a nearly vertical slab tied back to the deck by counterforts seven feet apart. Anchor ties were found to be necessary and were put in at 20 ft. centers being carried back to the foundations of a shed alongside the wall.

In Australian ports a type of precast wall called a reinforced trestle wall has been used for some years with apparently good results. They are formed with precast L shaped buttresses which are set at regular intervals on a prepared level foundation. These buttresses are flanged to hold precast reinforced concrete slabs which fill in the spaces between the buttresses. This type of wall has been used up to 27 ft. in height and the advantages claimed for it are economy, stability on bad foundations, flexibility where settlement occurs in the foundations, rapidity of erection and greater resistance to the chemical action of sea water as all its parts are seasoned on shore.

The ordinary type of reinforced concrete retaining wall having inside buttresses and vertical and horizontal slabs all cast in place was used in the construction of a pier at Padstow, Cornwall, England, which is 800 ft. in length by 40 ft. wide and which carries two railway tracks. The rise and fall of the tide at Padstow is about 20 ft. The foundation slab consists of mass concrete resting on solid rock and it varies from 3 to 9 ft. in thickness in order that it might be finished 12 in. above low water of spring tides. The height of the vertical wall is 23 ft. 6 in. Cross ties connect the two side walls at intervals, and the space enclosed by the walls was filled in with earth, etc. It will be interesting to know how long this structure will last, as its location is a very exposed one.

**Reinforced Concrete Cribs.**—Reinforced concrete cribs or caissons have been used for a number of years both in Europe and America in the construction of quay walls and breakwaters. At Norresundby Harbor, Denmark, concrete caissons 32 ft. 6 in. long, 8 ft. 4 in. wide, 25 ft. high and with a thickness of wall of only 5.1 in. at their base and 3.5 in. at their tops, were built on shore and launched sideways into the harbor. No failures from cracking during launching occurred but the wall thickness appears to be too light for permanent marine work.

At Copenhagen a quay wall 3,300 ft. in length has been constructed using reinforced concrete cribs of an average length of 162 ft. each. These cribs are 32 ft. in height by 16 ft. wide but with their bottom slab spread to a total width of 23 ft. The front and back walls average 10½ in. in thickness and are stiffened by cross beams and struts. These cribs were filled with sand and capped with a granite faced wall 7 ft. in height projecting 13½ in. beyond the face of the crib below. The granite facing is carried down 4 ft. 3 in. below the top of the crib for which purpose the front wall of the crib was recessed. These cribs were built in a temporary drydock large enough to accommodate three at one time and the concrete used in their construction was mixed in the proportions of 1: 2; 3.

Some large reinforced concrete cribs have been lately used at Victoria, B. C. These averaged 80 ft. long, 35 ft. wide, 39 ft. high and 2,500 tons launching weight. They were built on a timber pile skeleton wharf and launched on a cradle down a slipway situated at one end of the wharf. Five construction platforms mounted on rollers were used. When a crib was launched the remaining four cribs on the wharf were pulled along one space and the empty platform taken from the crib just launched was towed to the far end of the wharf and pulled up on the tracks by means of a short incline ready to receive the forms and reinforcement for another crib.

At Valparaiso, reinforced concrete monoliths 66 ft. long, 53 ft. wide, 50 ft. high and with a launching weight of 2,300 tons were used in the construction of a breakwater.

Lighthouses, in different countries, have been built either in part or wholly of reinforced concrete which material is especially suitable for such works when properly protected.

Reinforced concrete has not yet entered the field of drydock construction to any great extent. Several docks lately built have their walls or floors reinforced in part but they are really mass concrete docks into which reinforced steel has been introduced to take care of some probable tensile stresses.

**Reinforced Concrete Hollow Block Wall.**—In Halifax harbor, since 1912, there have been used three types of reinforced concrete construction. The reinforced concrete pile wharf is xemplified by pier No. 2, the concrete cylinder wharf by the Furness-Withy pier and a new type of reinforced concrete hollow block wall has been successfully used at the Halifax Ocean Terminals.

These hollow cellular blocks are 21 ft. 10 in. on face, 31 ft. from back to front and 4 ft 1½ in. high. They have reinforced concrete walls 8 in. thick and are divided by internal partitions into twelve cells or compartments. A standard block weighs 62½ tons and is reinforced with 1.49 per cent of steel. These blocks are set on a prepared foundation and built one on top of another to the required height. The three front compartments and the center compartments running from front to back are filled with concrete. The remaining compartments are filled with concrete up to the center of the second block above the foundations, the balance being filled with dredged rock.

At a level of 1 ft. below low water of spring tides the blocks are reduced in depth, being set back 4 ft. 8 in. from the face to allow of the building of a granite faced concrete coping wall. In this type of construction no concrete, plain or reinforced, is exposed above low water level.

**Reinforced Concrete Pile Wharf (Pier No. 2), at Halifax.**—The length of the structure is 800 ft., its width 235 ft. and the depth of water alongside varies from 34 ft. to 57 ft. below low water of spring tides.

The piles are 24 in. square in cross section, reinforced with eight round rods of size varying from 1 in. to 1¼ in. in diameter according to the length of the pile. The lengths of the piles ranged from 47 ft. to 77 ft. and a total of 1801 piles were used.

These piles were cast at the contractor's yard 7 miles from the site of the pier and were made of concrete mixed approximately in the proportions of 1: 1½: 3, the cement containing not more than 6.5 per cent of alumina.

Each bent consists of 33 vertical piles and six brace piles, three of which latter lean towards the north side and three towards the south side of the pier. The vertical piles are driven singly and in groups according to the concentration of the loads from the superstructure, and the brace piles are driven in such positions that their heads were built up along with the group of piles under each shed column. The bents were driven 18 ft. center to center. The total number of brace piles used in the work is 238.

The materials through which the piles were driven consisted of from 5 to 27 ft. of soft mud and from 2 to 12 ft. of hard clay, gravel and stones overlying the rock. The weight of the pile and hammer was sufficient to penetrate the soft mud while from 200 to 1,800 blows were required to drive the pile to refusal. Although the driving was very hard, the last few inches of penetration being at the rate of 1 in. to 30 or 40 blows, the pile heads suffered practically no damage. Nine piles, at various times, were pulled up after having been driven and on examination were found to have suffered no material damage either at their points or any part of their length. Test loads of from 90 to 120 tons were applied to individual piles with no resultant settlement where the pile had been driven to refusal.

The piles, after being driven, were extended up to deck level and the reinforced concrete deck system was built on them. This consists of transverse girders along the heads of the piles in each bent and longitudinal beams spanning from bent to bent carrying the floor beams and slab which was designed for a safe live load of 1,000 lb. per square foot. In order to protect the concrete against the action of frost and ice all surfaces between low water of spring tides and 18 in. above high water of spring tides were sheathed with 4 in. of creosoted plank.

**The Furness-Withy Concrete Cylinder Pier.**—The Furness-Withy pier at Halifax, completed last year, has a length of 590 ft. and a width of 90 ft. It is supported on 76 reinforced concrete cylinders in 19 rows of four cylinders each, and a solid concrete retaining wall under the shore end. The depth of water alongside ranges from 13 ft. to 46 ft. below low water of spring tides. ¼ in. steel plate cylinders riveted together were used as forms for the concrete supports and were left in place as a protection to the concrete.

The two side cylinders in each bent are 6 ft. in diameter and the two interior ones 7 ft. and they are spaced 25 ft. 9 in., 30 ft. and 25 ft. 9 in. center to center.

The concrete used for cylinder filling was mixed in the proportions of 1 part cement, 2½ parts sand and 5 parts broken gravel, and it was deposited under water by a bottom dumping bucket which held one batch of 20 cu. ft. 1¼ in. square twisted rods were set vertically inside the cylinders as the concrete came up. These rods were placed towards the north and south sides of the cylinders and their tops extended up into the superstructure of the pier in order to stiffen the work against lateral shocks. 1⅛ in. square twisted rods were placed in a similar manner on the west and east sides of the two inside cylinders to give longitudinal stiffness. The number of reinforcing rods placed in each cylinder and their lengths varied with the length of the cylinder.

The concrete filling of the cylinders was brought up to 2 ft. above the level of low water of spring tides in one operation. The laitance was then cleaned off and the necessary holes cut in the sides of the cylinders for the setting of the low water concrete braces.

These reinforced concrete braces consisted of two intersecting diagonal members 18 in. by 18 in. in section joined at their lowest extremities by a horizontal member 18 in. by 24 in. and having a short vertical strut projecting upwards from the intersection of the diagonals. These members are heavily reinforced with 1 in. and 1¼ in. square twisted bars whose ends were bent and extended beyond the concrete to allow their being thoroughly bonded into the cylinders and superstructure. Three braces were required in each bent, the center one weighing about 14 tons and the two outer ones 12 tons each. In addition to bracing the pier they acted as trusses and stiffened the transverse girders of the deck. They were cast on shore and were well set and seasoned before being used.

The two center cylinders of each bent were made of such lengths as to bring their tops to about the level of the underside of the braces and from that level to 7 ft. 6 in. above low water they were continued in timber in two thicknesses, the inner 1 in. being untreated spruce and the outer 2 in. of creosoted hardpine. The outside cylinders were carried up to 7 ft. 6 in. above low water in steel. After the setting of the braces and the completion of the center cylinders the concrete filling was brought up to the level of the underside of the deck girders. All parts of the concrete braces below the level of 7 ft. 6 in. above low water are sheathed with 3 in. thickness of timber in two layers. The pier deck, of slab and beam construction, consist of a 6 in. concrete slab carried by floor beams, longitudinal beams and transverse girders. The transverse girders, 20 in. by 30 in., extend from side to side of the pier across the tops of the cylinders and concrete braces. The longitudinal girders, 18 in. by 44 in., run from bent to bent at 10 ft. centers, and the floor beams, 9 in. by 18 in., running parallel with the transverse girders, divide the deck into 10 ft. squares. The deck slab is reinforced in both directions with ¾-in. round rods at 6 in. centers.

This arrangement of beams and girders lent itself well to the locating of the construction joints where these were least objectionable, which was midway between two bents. No longitudinal construction joints were allowed in the pouring of the pier deck, it being an unbroken rule that a complete strip 30 ft. 3 in. wide extending from side to side of the pier had to be poured in one operation. Such a strip contained 140 cu. yds. of concrete and was usually completed in less than 9 hours.

The surface of the slab was graded, screeded and floated as the work proceeded, no top finish being put on afterwards. This insured a compact slab of at least the required thickness with no horizontal joints between concrete and finish. The center 15 ft. of the pier floor was laid level and grooved to furnish foothold for horses, the remainder of the floor is laid with a grade of 1 in 90 to each side.

The pier carries a reinforced concrete shed 514 ft. long by 70 ft. wide. The walls of the shed are of 6 in. concrete stiffened with pilasters. There are two interior columns, 14 in. in diameter, in each bent dividing the shed into 20 ft., 30 ft. and 20 ft. bays. The height of the shed at the eaves is 16 ft. rising to 18 ft. along the center line. The transverse girders are 12 in. by 30 in., the longitudinal beams 10 in. by 21 in. and the roof slab is 3½ in. thick reinforced with wire mesh, and waterproofed with tarred felt, pitch and gravel roofing.

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**Change in Business Hours Spreads Peak Load.**—According to reports made to the Public Service Commission for the First District the change in business hours put in effect under the direction of the Health Department of New York City has resulted in less crowding on elevated, subway and surface cars in rush hours, and hence in improvement in the service provided. The rush hours have been lengthened, and the "peak load" has been spread over a longer period.

## Plant and Equipment Rental Prices

The following table showing the schedule of rental rates used during the season of 1917 on work of considerable magnitude is taken from a bulletin on Highway Cost Keeping issued last September by the U. S. Office of Public Roads and Rural Engineering. The information has been gathered from various sources and as complete data are given in connection therewith as were available at the time it was secured. While all of the rates given were those actually used on construction work, their use as a basis for rentals in specific cases is not recommended.

[illegible]

| [illegible] | [illegible] |
|---|---|
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
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| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| Crushers, with elevator and screen | 3.00 |
| Conveyor, gravity, per 100 ft | 1.00 |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| Diving outfit with pumps | 10.00 |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| Derricks, less than 30 ft | 1.00 |
| [illegible] | [illegible] |
| Derricks, circle swing | .25 |
| Elevators, platform or bucket | .25 |
| Elevators, with bins for concrete | .50 |
| Engines, skeleton, 3-drum | 2.00 |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| Engines, steam, horizontal, 11 to 40 HP | 1.50 |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| Engines, gasoline, 10 HP | 1.00 |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
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| [illegible] | [illegible] |
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| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| Motors, 2 HP | [illegible] |
| Motors, 5 HP | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| Pumps, centrifugal, 10-in., with motor attached | 4.00 |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| Pumps, duplex and triplex to 3-in. | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
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| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| Saw benches, with motor or gasoline engine | .50 |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |

Fuel and lubricants were not included in these prices, nor was the cost of repairs, all of which were borne by the organization using the equipment. All equipment was to be returned to the owner in good condition.

# Operating Cost of Electric Shovels in Underground Mining

For several years electric shovels have been used in underground iron mines and in coal, zinc, limestone and salt mines. Their performance has definitely established them as highly productive, economical factors in this class of excavation.

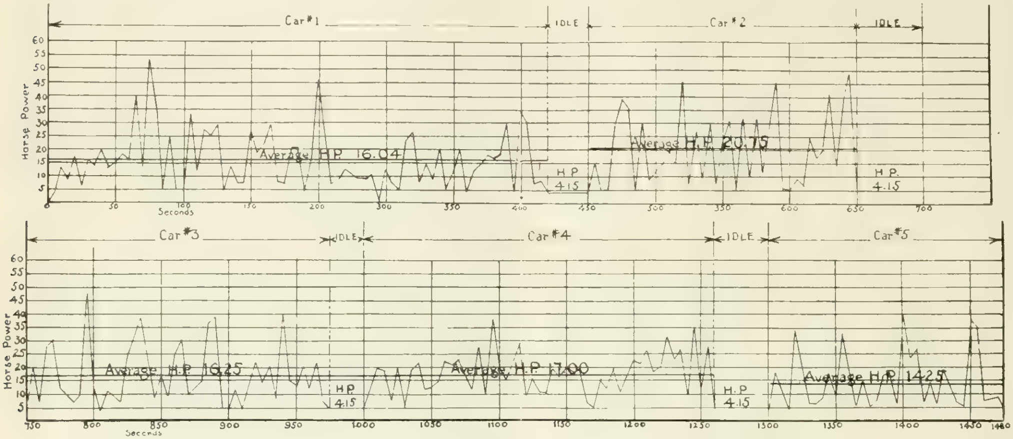


Fig. 1—Power Curve Thew Type-O Mining Shovel for Loading Five Consecutive Cars of Iron Ore.

The chart (Fig. 1) is a pictorial statement of the power consumed by one of these shovels in a New York iron mine. It is equipped with a 20-HP. motor and the record is for loading 5 consecutive cars of ore. For car No. 1 the power consumption averaged 16.04 HP.; for car No. 2, 20.75 HP.; for car No. 3, 16.25 HP.; for car No. 4, 17.00 HP.; for car No. 5, 14.25 HP. Or an average of 16.86 HP. for the total five cars.

A detailed statement of the complete operating costs of this shovel for the last four months of 1917 and the first five months of 1918 is given in Table I.

These costs cover all the expense involved in actually loading the ore and tramming it about 300 ft. to the main haulage way. They include, also, the expense of moving the shovel to different levels and locations. The ore was loaded into 3-ton gable bottom cars.

Under identical conditions the per-ton loading cost by hand-labor was 30 ct. and by shovel 16.6 ct. The saving per ton effected by the shovel was 13.4 ct. or $5,000 in nine months.

A northwestern iron company has used a similar elec-

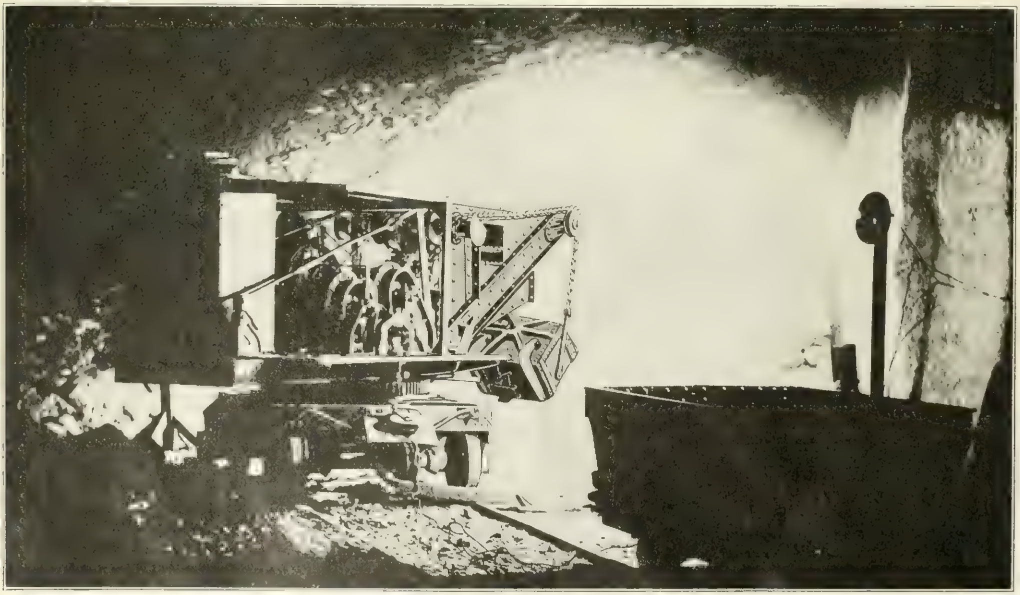


Fig. 2—Thew Shovel Mining Iron Ore in a New York State Mine.

TABLE I—OPERATING COST OF ELECTRIC SHOVEL IN UNDERGROUND MINING.

| Month 1917. | Cars | Tons | Labor | Supplies | Power | Total cost | Cost per ton |
|---|---|---|---|---|---|---|---|
| Sept. | [illegible] | [illegible] | $[illegible] | $[illegible] | $[illegible] | $[illegible] | $0.[illegible] |
| Oct. | [illegible] | [illegible] | [illegible] | [illegible] | 15.[illegible] | [illegible] | [illegible] |
| Nov. | 378 | 1,042 | 204.00 | 122.86 | 3.24 | 330.10 | .317 |
| Dec. | 1,148 | 2,296 | 384.00 | 11.54 | 10.10 | 405.64 | .177 |
| 1918 | | | | | | | |
| Jan. | 1,064 | 2,128 | 400.00 | 56.05 | 9.70 | 465.75 | .219 |
| Feb. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .203 |
| Mar. | 1,756 | 5,268 | 800.00 | 241.80 | 17.00 | 1,058.80 | .201 |
| April | 2,095 | 6,285 | 832.00 | 177.41 | 18.90 | 1,028.31 | .164 |
| May | 2,390 | 7,170 | 864.00 | 238.29 | 24.50 | 1,126.79 | .157 |
| Total | [illegible] | [illegible] | $4,824.00 | $1,225.17 | $122.32 | $6,171.48 | |
| Monthly av. | 1,447 | 4,141 | 536.00 | 136.13 | 13.50 | 685.72 | $0.166 |

tric shovel for about 4½ years. The ore was 25 per cent fine, 75 per cent lumps, the largest pieces being 2 ft. x 2 ft. x 18 in. This shovel loads 150 to 220 tons daily.

The following table gives the tonnage and the average cost per ton, for each fiscal year, ending June 30, from 1914 to May 1, 1918.

| | Electric shovel. | | Hand operation. | |
|---|---|---|---|---|
| Year | Tonnage | Cost | Tonnage | Cost |
| 1914 | 20,820 | $0.268 | 102,438 | $0.466 |
| 1915 | 24,497 | .253 | 34,222 | .324 |
| 1916 | 32,261 | .304 | 84,485 | .318 |
| 1917 | [illegible] | .344 | 77,653 | .391 |
| To May 1, 1918 | [illegible] | .408 | 59,646 | .510 |

Fig. 2 illustrates a Thew electric shovel, built by the Thew Automatic Shovel Co., Lorain, O., mining iron ore in New York.

In a western zinc mine a mining shovel loaded 125 cars in 5¾ hours at a cost of less than 9 ct. per ton, including tramming. This represented a reduction in cost of handling material and hauling it to the shaft for hoisting to the surface from 16 ct. and 18 ct. per ton by hand to 9 ct. by the shovel, a direct saving of 45 to 50 per cent. Five of these shovels are now working at that mine.

## Wrecking an Old Building With Dynamite

The following method was successfully employed by Mr. Norman Supplee, Landscape Engineer, for tearing down an old barn. The building was of stone construction up to the ridge of the roof on two sides and frame on the other two sides. One side had an elevated driveway to the barn floor.

About 1/6 lb. of 40 per cent dynamite was placed in the wall where each of the joists went into it. A heavy cap of plastic clay was placed over each charge. Similar charges were placed wherever there was a junction of two joists. Three blasting machines were used, as it was desired to fire all charges at one time so as to get the cumulative effect. Two machines took care of the exterior of the building and the roof and the third machine was connected to the charges in the base of the foundation walls. These latter charges were somewhat heavier than the others. The dynamite was laid up against the wall spaced about 10 ft. apart and also covered with heavy caps of plastic clay.

Of course, it required three men to operate the blasting machine. The handles were pulled up. Each man was asked if he was ready. At the word "Fire," two men at the machines connecting with the roof and exterior charges pushed down their rack bars. About two seconds later the machine connected to the foundation charges was operated.

The roof spread and dished downward; the joists underneath gave way and the stones in the foundation wall semed to crumble apart. The entire building came down in a heap, the roof spread out, well broken up, on top of the mass of masonry.

After the debris resulting from these shots had been cleared away, an excavation was made underneath the foundation walls and ½ lb. charges of dynamite placed every 5 ft. all around the wall. These shots were also fired simultaneously with the blasting machine. After all was over, what remained of the foundation walls lay on top of the ground so well broken apart that the pieces of stone were easily handled by the laborers.

# Progress, Prospects and Pitfalls of the New Profession of City Manager*

By O. E. CARR

City Manager, Springfield, O.

It is now 8 years since the city of Lockport, N. Y., became interested in the new form of government which she called the Lockport plan. But Lockport did not originate the plan, it came directly from the minds of men who were studying municipal matters. Briefly the plan of the theorists was:

1. To throw municipal government into a single elective body.
2. To place the number of commissioners at five, this being considered to constitute a workable and logical number designed to form the legislative body of the city.
3. To embody in the plan the principles of initiative and referendum and recall.
4. To arrange that a manager be appointed who should constitute the executive head of the city.

The Lockport Board of Trade sought to have the New York Legislature pass a bill enabling any third class city in the state to be governed by this form of government. The bill failed. It was in advance of the thought of the legislature. That was a short 8 years ago. Such a law was passed in New York in 1914. Lockport business men are just now embarking on a second attempt to secure the city manager plan for Lockport.

Since we met last year a decisive year of the world's history has passed (never a year of such stupendous undertakings). Naturally it would tend to restrain small movements like that of changing the system of local governments.

But the movements of government are bound up in the world movement, material progress has not been so rapid but the idea itself has been immeasureably advanced by the great war. Last May our Secretary reported 123 cities committed to the city manager plan. Not a single charter city has yet gone back to a former plan of government. But best of all we chronicle a change in the attitude of the public mind towards the plan. When we last met rural communities were debating the commission manager plan. City high schools were working upon it. It was considered a debatable question with much to be said upon both sides, but since the immersion of the country in the great war our national thought has been clarified and purified in the determination to succeed fully in the overthrow of our enemy. We have tried Committees, Boards and Groups. It was our usual way of working. But we were forced to discard them and to place the responsibility in a single executive head. Never has there been such an innovation in the government. One after another the great Boards that were to accomplish so much, were put in the discard. At present Ryan and Schwab, single executive heads in the air craft and ship building, are accomplishing what we hoped to in the beginning.

We need argue no more, proof is before us, the public has been taught by heart breaking lessons, for this time we have the minds of the public at large turned towards the principles of the plan, at least without hostility.

But the thought of the public at large has changed no more than the thought of the managers themselves. We have come a long way from the atmosphere of our first meeting. Then we were men upon whose shoulders fell responsibility for good government and good morals, for development and proper growth, for settling immense problems for the city we served. We had, to put it mildly, a large sense of the community's need of us and of what we individually contributed to our various communities. None of us managers in those days were inclined to underrate ourselves. You remember that early feeling on the part of the citizens in which the majority of managers acquiesced was, that the manager was not only responsible for the administration of municipal matters but that he was also responsible

*[illegible]

for the direction of thought of his community and its activities in every line. In other words that he was a sort of superman (many sided and versatile) the leader of his community and a man to be consulted in every venture. Now, of course the manager as a public spirited citizen, is and should be interested in all things which make for the betterment of community life, but he has one duty—the administrative details of his city. He is not the only competent man in his community nor is he the only thinker. The most successful government is the one which is able to secure the most interested service from its citizens. Certainly the manager should not attempt to do all of the work pertaining to the growth of the city. I was aware that there have been different practices along this line. Some managers have been very loath to allow even a community activity like the Red Cross or War Chest to operate without themselves taking the reins by means of some high place. In every way possible they have sought to keep their hands on every activity in the city. Can we doubt that because they are mere men, and not at all super, that they have neglected duties essentially their own and they have dissipated their energies in directions which should be managed by other citizens? There is no doubt that logically speaking such a many sided manager might do real harm in the community. His activity in all public questions would result in a like passivity on the part of citizens trained and qualified for just such prominence.

An illustration to make this point clear. It is the duty of a manager to obtain the best service at a reasonable rate from a public service corporation. Suppose that he fails in his attempt to secure creditable service; then it is his duty to go before his commissioners and his public with facts and figures to prove to them concretely that the corporation is not rendering adequate service nor service equal to the amount of money expended for it. It is not his duty, as I see it, to agitate therefore for municipal ownership of such public utility. This should be left to the commission or should be taken up by the Chamber of Commerce or various city clubs. It is obvious since efficiently operated public utilities are their own best argument for municipal possession the manager should expend every energy towards giving service from those already possessed by the city since this is his direct duty.

By this attempt to standardize, in a measure, the duties of a manager we are attempting to increase his efficiency in the exercise of them. Our managers were men from other professions who carried to the new field no wealth of experience. They cannot do well the work for which they are directly responsible if they assume the direction of all activities within the city.

If we have saved money, conserved health, contributed to the growth and well being of our community in large contrast to previous government, it is not due so much to our personal ability as it is to a form of government the principles of which are easy in operation and the responsibilities of which are definitely fixed thereby making success a natural consequence.

### Prospects of Commission Manager Form.

During the past year every effort of our citizens has been directed in various activities in connection with winning the great war. The drawing of municipal charters has for the most part been given up until our victory is finally won. But it must not be forgotten that those activities of war have trained a body of citizens in putting over public enterprises. Four-Minute-Men, Liberty Loan and War Chest workers are going to become interested in whatever is necessary in their communities. On account of the training they have received they are going to make short work of educating the public to new ideals of government. Moreover as stated before, this public mind will have no difficulty in meeting the ideals of the commission manager plan. The march of the human mind is slow ordinarily but there never was a time when the people at large will so accept the plans of a new government as now. There is positive pre-disposition towards it. Not in vain have been our great public failures in connection with our aircraft, shipping and ordnance boards. Not only does the public see that a single head is necessary for a department but it sees that that head must have had specialized training in the department and line which he heads. This lesson has cost us the lives of many of the boys we have lost on the other side.

The cities under the commission manager plan have moved along, adapting themselves to increased expenditure without increased revenues. Not one of them has gone back to the old charter form. In a very few of them old politicians have taken the public unawares and are back in power. I cannot prophesy just how that condition will end for even when politically administered the city manager plan shows good results simply because it fixes individual responsibility and there are many ways by which a public official in these days may be made to act. Altogether the future looks very bright for the Commission Manager plan.

### Pitfalls or Obstacles in the Way of the New Profession.

This part of the subject brings to my mind the query as to whether our work has as yet risen to the dignity of a profession. Can we say as yet that it is work which requires a specialized training? We are not even yet arrived at a point where we can settle the matter of suitable training absolutely definitely.

There is every indication that we have a new profession in city managership. At least a number of us have gained our experience in one place and have been promoted on account of our experience to others. But I do not believe that a City Manager will become a permanent fixture in his community, nor do I believe that it would be desirable except in very exceptional cases. Our school superintendents meet this same condition. We are practically agreed that our schools are benefitted greatly by an occasional exchange of executives. The infusion of fresh ideas, new plans and different methods in a community benefits it and keeps the ruts from forming. It will be so with the managers. A conscientious manager will be popular one month and unpopular the next. It is but a matter of time when he will have offended a considerable number of citizens by not seeing just their way in matters which if undertaken, would have benefitted each of them materially. The ungratified citizen becomes a publicity man against the manager and the harm he is able to do will be in proportion to the friends he has in the community. Therefore, the time will come in the history of each manager just as in the case of superintendents of schools when his best field for effort will be in a new locality.

Small communities are sometimes apt to think the salary asked by an experienced man is excessive, so they will select a young man who may or may not be good manager material, or a man who has served in various other political offices. Of course I must discuss the matter as it appeals to me. Many professions have been called upon in the emergency to furnish managers. Some cities have sought the usual politicians. This is pitfall number one.

I can see why the engineering profession has been called upon so extensively to furnish managers. I can see why expert financial ability is an asset, why general publicity work might operate to advantage, why Chamber of Commerce men might do good work, but I will never be able to see why a perfectly good, honest plan of government should be prostituted by the appointment of a man accustomed to judge by political ideals. Human beings cannot help being products of their environment. Especially is this true of the moral senses. A politician will not administer government save as it makes for his own selfish ends. He cannot see further than that. Some of our cities which started right, have been manipulated so as to allow a politician to become a manager thereby discrediting the plan.

A second danger lies in the mere human quality of managers. Power is a hard thing for a human being to stand. A manager must curb his tendency to high handedness, bull headedness or whatever name you may give the quality. Some prominent public officials have not been proof against this trait. I have no doubt that several managers have rendered their usefulness negative by just such a development. It has certainly caused some dismissals.

A third obstacle which is so insidious that it is dangerous is in the case where a manager has decided it is his duty to hold onto his job. His every official act is apt to fall in the line of least resistance,—to attempt to give a good administration so far as it goes, to placate the angry, to flatter the important, to reserve decision where citizens might be rencered dissatisfied, to promise citizens favors which he knows can never be granted. In other words to tread a safe path conciliating, promising and half way rendering service to his city. He brings ill favor on a plan which is essentially good and at that his tenure of office has not warranted his plan of action.

But above all things the manager must remember that it is only his work to which he must devote his energies with patience, with thoroughness and with honesty and with perseverance,—that he is only the administrative head of the city. He is naturally interested in government and if his aim to interest the public in both the aims and accomplishments of the administration.

The second class of pitfalls relating to the profession are those which grow out of relations with the commission. In the three cities I have served as manager, the commissioners of Springfield, O., are the only ones who themselves have accepted fully the principles of the city manager plan, who do not hasten to ascertain the political aspect of situations which present themselves. Though I have been fortunate in this respect, there have been men in every commission who were honestly trying to carry out the principles on which they were elected by the people.

I have served a city where the commission upon taking office desired to make a general housecleaning, of all officers whether they were protected by civil service or not. It was a condition where I counselled strongly waiting but where I finally acted because I realized that the commissioners knew the local condition where I did not. That one situation taught me a lesson. I had to bear the criticisms of the public when all these officials were re-instated by the courts. The commission did not come forward and advise that these wholesale dismissals were made by me at their request and in spite of my objections.

The third class of obstacles relating to the profession may be relegated to the people themselves. Some cities have adopted the city manager plan without any idea on the part of the mass of the citizens of what it really means or really stands for. They vote for it because they thought that nothing could be worse than what they had.

All Americans claim the right of an unmuzzled criticism of their public men. This right is made use of when it comes to the manager. If a manager is young they say—"what does that kid know about running a city—let him practice somewhere else." If he is older, "he is an old fogy and needs to wake up." If he is affable and friendly they say—"he tells too many people his business—he had better stick around the office and work." If he attends strictly to his business and is a quiet sort of chap then he is said to be unapproachable and gruff. If he is well dressed he is a dude who thinks only of his clothes. It is pretty hard to please all of the people and popularity at best is of short duration. In all of our cities there is an element that belongs to the old political school. It is going to take many years before that influence is entirely gone. They do not intend to be pleased with the new plan and they bury themselves finding fault.

These are all small things but they are obstacles to the city manager plan but I have faith, never so much as now—that managers are going to be able to work out their problems, that commissioners are getting better every year, that people are beginning to take a more intelligent interest in government and that they are going to be tolerant of effort and more intolerant of inefficiency, that honesty is somehow going to be infused into the governmental conscience and that a favored class is in the process of elimination. For first, last and all of the time our basis of action must be in a free government as in ours, the greatest good to the greatest number.

**New York Street Railways Carry 2,000,000,000 Passengers in Year.**—Travel on the street railroads of New York City, which includes elevated railroads and subways, has reached the figure of two billion passengers per year, according to estimates prepared at the offices of the Public Service Commission for the First District. Between July 1, 1917, and June 30, 1918, 1,975,482,316 fares were collected, an increase of [illegible] over the previous year.

# Pneumatic Caisson Method of Quay Wall Construction at Halifax

One of the most unusual features in the construction of the new ocean terminal at Halifax, N. S., was the use of a self-floating, submerging and raising type of mobile pneumatic caisson for building the concrete quay wall. An interesting description of this particular feature was given by Mr. J. J. MacDonald, Assistant Engineer, Halifax ocean terminals, in a paper presented Sept. 11 at the Third General Professional Meeting of the Engineering Institute of Canada. The following notes are taken from Mr. MacDonald's paper:

In the layout and construction of the landing quay and piers of the Halifax ocean terminals the quay walls are the most important element. The harbor bottom at the site is rock of a shale formation which has been subjected to much irregular movement and distortion. Its depth varied from 20 ft. to 50 ft. below the datum (L. WL. O. S. T.), except for two sections aggregating about 1,400 ft. in length, measured along the quay walls, where the depth is from 55 ft. to 70 ft. below datum. This rock was overlaid by a layer of black mud, etc., ranging in thickness from 2 to 10 ft., except at the section where rock is from 60 to 70 ft. below datum, where it was overlaid by 15 to 30 ft. of glacial deposits of red and blue clay interstratified with sand.

Fig. 1—Diagram of Caisson

The quay wall is of the cellular reinforced concrete block type. The first unit, 6,530 lin. ft. in length, varies in depth from 30 to 45 ft. below datum and is founded upon the rock bottom dredged to required depth except in the deeper sections where a spread rubble base of 45 ft. (below datum) level is provided. The construction of the wall of cellular blocks placed in stacks demanded in general a means of cleaning and inspecting the bottom before the blocks were placed, and, in particular, a means of placing supports or pedestals at accurate elevation to receive the base block and support the whole stack and erection plant, until the concrete filling was deposited. It was decided to apply the pneumatic caisson process on the work to an area about 36 ft. wide by 6,530 ft. long, at depths of water varying from 30 ft. to about 55 ft. (allowing for rise of tide). The comparatively small amount of work required per unit of area necessitated rapid and economical movement of plant.

**General Features of the Caisson.**—The size of the caisson is plan was determined so that the foundation site for one wall unit (22 ft. x 34 ft.), the area of one base block could be covered, with a small margin to take care of inaccuracy in setting. This gave 26 ft. x 38 ft. as the horizontal dimensions at the cutting edge. The working chamber was 7 ft. high and the cutting edges were 4¼ ft. thick at the roof level. Concrete stiffened and armored with steel was used for the cutting edges, and the roof of the working chamber was concrete covered with an air-tight skin plate The man shaft was 30 in. and the machine shaft 36 in.

**Operation of Caisson.**—A centrifugal pump on a vertical shaft directly connected to a motor placed at the top was installed to handle the water ballast. The pump itself was paced on the bottom of the ballast chamber. A small sump was placed in the bottom of this chamber and in the bottom of the buoyancy chamber, to either of which the pump suction could be connected. The pump discharged directly through a pipe to the sea-valve. It was proposed to fill the buoyancy chamber from the ballast chamber by opening a gate-valve in the separating wall

An inherent defect in the unwatering system became manifest the first time the caisson was submerged. It happened that the cutting edge landed with one side on a high point of rock so that the caisson was thrown over at an angle of 10° to the vertical. Although the buoyancy chamber was not flooded, some water leaked into it before it was attempted to raise the caisson. When the ballast chamber was unwatered, the bell rose some distance from the bottom; but the water in the buoyancy chamber prevented complete flotation and it proved impossible to remove this water with the pump, because it surged from side to side with the slight roll of the sea, and the water could not be collected by the sump.

As this condition was liable to occur at intervals in the work, a remedy had to be devised. The contractors lined the inside of the buoyancy chamber with rubberoid, covered with sheathing, and made connections to admit air into the chamber from the compressors and fitted a blow-off pipe with valve at each corner. By this method the water was forced out of the corners, but the chamber soon became very leaky, on account of blowing out the caulking.

In the construction of the caisson a sump should have been placed at each corner of the buoyancy tank and connected by a branch pipe, with valve, to the pump suction.

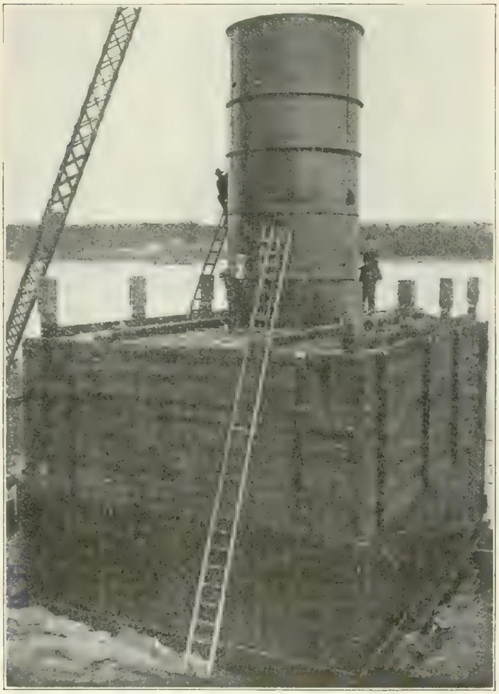


Fig. 2—Caisson Ready for Launching.

In actual operation the bell was moved to an adjacent setting as follows: The buoyancy tank was unwatered; then a volume was pumped out of the ballast chamber sufficient to raise the cutting edges clear of the pedestals. The bell was then warped to the next site. On account of the conditions outlined above, it became necessary to maintain air pressure in the buoyancy chamber to counteract the leakage.

Line and levels were transferred to the working chamber at each setting as follows:

Points were located on the upper deck of bell from transit on shore. The distances from these points to fixed reference points at the corners of deck were measured and the angle inclination of bell (from plumb), observed. Then by calculation, line and position were set out in working chamber by measurements from fixed reference points at the corners of chamber. The levels were given on the top of lock and transferred directly through the man shaft by a steel tape to a bolt driven in the rock in working chamber which served as a B.M. for the setting.

**Auxiliary Plant.**—In the operation of the caisson, plant used was as follows:

1 tender scow, steel frame, 100′ x 32′ x 4′ 8″.
2 steel water tanks.
1 20-ton derrick.
2 No. 13 "Ames" locomotive type boilers.
1 "Beatty" 3-drum hoist without boiler.
1 "Mead Morrison" derrick swinging engine.
1 No. 7 "Vim" engine.
1 10″ x 10″ x 12″ Rand straight line air compressor.
1 36″ x 8′ Rand air receiver.
1 12″ x 16″ x 12″ Rand compressor.
1 42″ x 10′ Rand air receiver.
1 Blake Knowles 10″ x 6″ x 12″ duplex pump.
1 "Bowden" boiler feed pump.
1 25 hp. adjustable speed motor set.
1 Morris submerged centrifugal pump.
1 Man lock with 2 air lock doors.
1 air lock for material shift.

The air was supplied to the working chamber from the low pressure reservoir on the scow, and a high pressure line was installed in the bell for use in drilling, etc.

The working chamber and shafts were lighted by electricity supplied by the motor on the scow.

The working chamber was equipped with a 4-in. blow pipe, a ¾-in. whistle pipe and a 3-in. wash-pipe. These with the high and low pressure air-pipes, extended from the roof of the working chamber, through the ballast chamber to the top platform.

In carrying out the work at Halifax all the rock foundations were prepared with the caisson, but on the rubble mound foundations it was not used. On this portion of the work bag work was placed continuously along the lines of the toe and heel of the quay wall by helmet divers. The bag work was checked to correct elevation by hanging screeds suspended from a framework above water level.

**Costs of Plant and Operation.**—The contract for the plant was let in spring of 1914. The first cost of the diving bell was about $17,000, tender scow with equipment cost about $24,000.

In the operation of the diving bell the costs were approximately as follows:

| | |
|---|---|
| Labor, 3 shifts of full crews, per 24 hr. | $131.00 |
| Supplies—Oil, etc., per 24 hr. | 10.00 |
| Coal, per 24 hr., 8 tons. | |

To these figures must be added the cost of daily tug service, which in this case was computed at $30 per 24 hours.

The speed of the work varied considerably according to the condition of the bottom. During the latter period of this work 5 sets per week were generally made—and the best record was 6 sets per week. The foundations were prepared and the pedestals placed for one wall unit, 34 ft. x 22 ft. in area, at each setting.

## Breaking Up Concrete Abutments With Dynamite

The following method is employed in breaking up one of the concrete abutments of a bridge that had become undermined, and had fallen into the channel of the stream. The concrete was about 3 ft. thick and 7 ft. wide, and was covered with about 18 in. of water. The wings were sticking up out of the water and obstructed the channel.

The blaster used 40 per cent dynamite on the work, the charge being loaded in this way: 5 cartridges (2 lb.) were simply laid on top of the concrete about the center of the block, 5 more sticks were laid in the groove formed by the junction of each wing with the main body of the block; in all 15 cartridges of dynamite were used. The center cartridge in each group of 5 contained an electric blasting cap and copper wires connected up all 3 charges. Nothing whatever covered the charges except the 18 in. of water; in other words, there was no tamping or mudcapping.

The shot broke off the two wings and broke the center section in two parts in the middle. The entire cost of the work was $3.86 itemized as follows:

| | |
|---|---|
| Dynamite and exploders | $3.36 |
| Blaster's service, 1 hour | .50 |

The blocks left by the blast were small enough to be handled by laborers, and were used as the foundation for a new abutment which was shortly afterwards built. The work was done by Mr. W. V. Spencer for the Superintendent of Highways of the Town of West Almond, N. Y.

# Line Hooks, Ladders and Friction Fenders' Strips at Government Lock, Troy

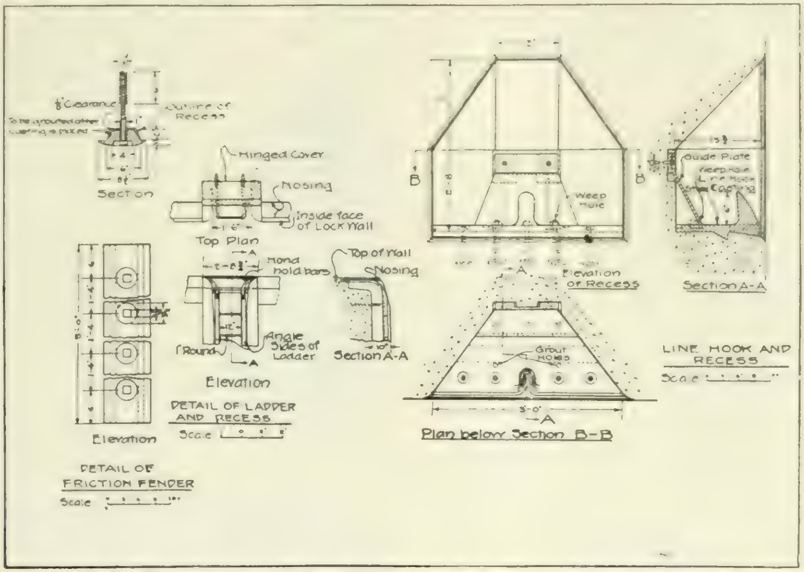
The recently completed Government lock and dam in the Hudson River at Troy, N. Y., has a number of details that are somewhat of a departure from ordinary practice. Several of these features are described by Willson Y. Stamper in the September-October Professional Memoirs, from which the matter following is abstracted.

**Line Hooks.**—In each wall of the lock at 50-ft. intervals, are line hooks to aid in snubbing or steadying vessels during the operations of filling and emptying the lock. The height of the bottom of the line hook recess above the water level of the lower pool is 12 ft. Line hooks are also placed at similar intervals in the lower guide wall of the lock at an elevation of 9 ft. above pool level.

The line hook and recess were designed with a view to making the catching of the hook as simple as possible. In this type of hook and recess, the curved surface of the hook, the converging sides of the recess, and the guide plate back of the hook, all help to guide the loop of rope over the line hook. With this design, if the hook hits any part of the recess it is almost certain to go over the hook. The details of this line hook are shown in Fig. 1. The hook and its base plate are of cast steel.

**Ladders.**—At convenient locations in the lock and guide walls are situated ladders placed in recesses and extending from the lower pool level to the top of the walls. These ladders have sides of steel angles with 1-in. iron rounds. The depth of recess is 10 in. except at the top where the hand-hold deepens the recess 12 in. more. This large recess is designed to give the best possible means of access to the ladder. To descend, one first steps into the recess between the hand bars, stoops down to grip the bars and then steps onto the top round of the ladder without danger of losing balance. The continuity of the top of the wall, however, is preserved by means of a hinged cover of wood which is flush with the top of the wall. The use of this cover prevents accidents to anyone who otherwise might trip over one of the recesses. Where anyone is descending or ascending the ladder this cover is thrown back upon the lock wall. The ladder and recess are shown in Fig. 1. No part of the latter or hand-rail projects beyond the face or top of the wall. Hence, there is no interference with boat lines dragged along the cast-iron nosing.

**Friction Fenders.**—In order to prevent damage to the lock walls by vessels, cast-iron friction fenders are placed every 10 ft. along each wall of the lock chamber. These fenders extend from a point about 7 ft. below the level of the lower pool to within 1 ft. of the top of the wall, a height of 30 ft. The fenders are cast in 5-ft. lengths, and are bolted to the lock wall by Richmond screw anchor bolts, spaced 1 ft. 4 in. on centers. An elevation and section of the fender casting in place is shown in Fig. 1.



Details of Line Hooks, Ladders and Friction Fenders for Government Lock, Troy, N. Y.

# New System Enables Philadelphia Terminals to Handle 20 to 60% More Freight

By allotting a space at freight terminals to large merchants and truckmen receiving less than car load shipments regularly, and by the railroads segregating the consignees' goods and reducing the free period from 48 to 24 hours, the city of Philadelphia, probably one of the most congested cities along the Atlantic Coast, has not only relieved the congestion of its 72 freight terminals by this method of handling goods, but its terminals are handling more freight with the same facilities and without additional man power.

This system, states The Commercial Vehicle, to which we are indebted for the matter in this article, was placed in effect on May 1. By means of it the most congested terminals have been able to handle between 20 and 60 per cent more freight with the same number of men they previously employed, and every terminal in that city is cleared of practically all freight by noon.

The new system has been successful because the railroads, the merchants and the truck owners have all co-operated. By this method of handling the less than car load freight it is the work of the railroads to see that all freight is placed in its proper location at the terminals so that the merchant or truckman will be able to find it and remove it without any loss of time. It is also the work of the agent of every terminal to notify the president of the truckmen's association each evening between 5 and 6 o'clock the amount of freight at the terminal that the free time has expired on, and that should be trucked to the warehouse.

The merchant is co-operating by removing his freight as soon as possible or within the free time period. In many instances the merchant has to cart his freight a longer distance than he had to before the new plan was adopted. This has to be done, because a few of the smaller terminals have not the facilities to allot a space to all large merchants in the vicinity of the terminal.

Sixty-five cartagemen have been allotted a space to segregate their customers' freight at the terminals, and it is their work to see that no goods in their section is in the terminals over the 24-hour period. It is also the work of the president of the cartagemen to see that all freight is removed from the terminals to the warehouses after the 24-hour free time has expired. In this work the president is notified by telephone at his office tween 5 and 6 o'clock every evening of the amount of freight that each terminal has that the free time has expired on. After this information has been received the president notifies any of the 65 cartagemen who are bonded to handle this freight between the terminal and the warehouses, the amount of freight that will have to be removed the following morning.

The new system of handling the less than car load freight through the terminals of Philadelphia has been so successful that the average total tonnage of freight each day left over the free period at the 72 terminals can be handled by three trucks.

## Operating Cost of Motor Trucks

The New York State Railways employ a number of motor trucks for overhead line work and for delivery purposes. It also uses several automobiles. Careful cost records of the truck and car service are kept by the company and economical operation is secured by thorough analysis of the detailed cost data thus obtained. To facilitate analysis the several costs, together with the car mileage for each truck, are tabulated each month for the month and for the year ending with that month. The following figures, abstracted from an article by C. L. Cadle, Chief Engineer, Rochester Lines, New York State Railways, in the Electric Railway Journal, show the average operating costs for four trucks for the year ended Dec. 31, 1917:

AVERAGE OPERATING COSTS FOR 4 WHITE TRUCKS.

| | |
|---|---|
| Car mileage | 6,266 miles |
| Cost gasoline, per car mile | 9.8 ct. |
| Cost oil, per car mile | 0.8 ct. |
| Cost tires, per car mile | 12.5 ct. |
| Cost repairs, per car mile | 8.4 ct. |
| General expenses, per car mile | 2.8 ct. |
| Total, per car mile | 34.3 ct. |

The above refers to 1-ton White trucks carrying 6,000 lbs., and used for overhead line purposes.

The automobiles are employed by the several heads of departments in conducting the inspection work. The duty of these runabouts, of course, cannot be compared with that of the trucks. However, the following data are interesting from the standpoint of showing the operating costs of so-called pleasure vehicles:

AVERAGE OPERATING COSTS OF 5 FORD RUNABOUTS FOR YEAR ENDED DEC. 31, 1917.

| | |
|---|---|
| Car mileage | 7,469 miles |
| Cost gasoline, per car mile | 1.7 ct. |
| Cost oil, per car mile | 0.1 ct. |
| Cost tires, per car mile | 1.7 ct. |
| Cost repairs, per car mile | 1.6 ct. |
| Cost general, per car mile | 1.8 ct. |
| Total, per car mile | 6.8 ct. |

The high tire cost for trucks is stated by Mr. Cadle to be due to the fact that vehicles were equipped with pneumatic tires when orginally purchased. He adds that it was found after considerable experience that a special solid tire purchased from the Overman Company, New York, gave the best tire economy on a car-mile basis. These tires cost approximately $650 for one complete set, dual rears and single fronts. Offsetting this cost, however, is the fact that these tires have a guaranteed mileage of 15,000 as against 6,000 miles for the pneumatic tires. The New York State Railways' experience has been that the use of these tires reduces their tire cost per car-mile by about 50 per cent.

## Precautions for Use of Reinforced Concrete in Marine Structures

In his paper, "The Use of Reinforced Concrete Construction in Harbor Work," presented Sept. 11 at the Third General Professional Meeting of the Engineering Institute of Canada, Mr. A. F. Dyer gives the following conclusions on points which require particular attention for the successful use of reinforced concrete in marine structures:

Only rich, dense concrete of first class quality in every respect of materials and workmanship should be used. Fresh water only should be used and excess of water in mixing should be particularly guarded against as also too dry a mixture.

The building of the forms should be carefully inspected and watertightness, as far as possible, sought after, so that stony streaks from which the liquid cement has leaked may be eliminated. A smooth face is very desirable.

All reinforcing steel, whether in piles, slabs, beams or walls, should have at least 2 in. of sound concrete covering and more wherever practicable.

In climates where ice occurs during the winter all concrete surfaces between low water of spring tides and some distance above high water should be protected by timber or other sheathing. In warmer climates a similar protection would probably be found beneficial as a protection against the continual drying and wetting of the concrete which action appears to have a tendency to increase its porosity. The sheathing would also protect the concrete against abrasion by floating debris and the chemical action of the seawater.

Precast members are better than concrete cast in place, especially below high water level. Concrete piles should always be long enough to reach above high water after being driven.

The painting of all concrete surfaces above high water and below deck level with a waterproof paint in order to exclude the salt moisture laden air should be considered, especially in warm climates. In place of paint a more permanent waterproof protection might be obtained by applying a good coat of cement "gunite." This is a question which has yet to be settled, and it is a very important one to the life of reinforced concrete in sea water.

Careful periodical examinations, at least twice a year, should be made of every reinforced concrete marine structure so that deterioration of the concrete, corrosion of the steel or displacement of the protection sheathing may be discovered as soon as possible and the necessary repairs be made at once before serious trouble sets in. The idea that a reinforced concrete structure is one which can be left to look after itself and which will require no maintenance, is not only a mistaken one, but a very dangerous one.

## Blasting Stumps From Frozen Soil

Ordinarily, it is not advisable to blast stumps when the ground is frozen. The frozen soil holds the stumps tighter in the ground, necessitating the use of more dynamite to get them out, and it is more laborious work to get the bore holes down in frozen soil. However, occasionally emergencies arise that make it necessary to get out stumps in winter when the ground is frozen. The following is a description of a method employed in removing 50 or 60 stumps from a farm near Florence, Ky.:

A mattock was used to cut the frozen ground or rather to make a small hole alongside of the stump. After getting down below the frost level, the bore hole was finished with a dirt auger. The stumps were beeches 18 to 42 in. in diameter and all except three were green.

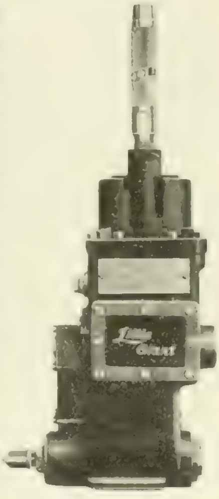
On the smaller stumps but one charge was used; this was placed well down into the ground. It is advisable to load this way to avoid splitting the stump. A deeply placed charge results in lifting the stump out on an inverted cone of earth. A charge placed close up under the stump is very apt merely to split it and allow the force of the explosion to escape into the air.

On the larger stumps, distributed charges were used; that is, light charges were put under the main roots and a main lifting charge deep in the ground under the center of the stump. This method of loading requires the use of electric blasting caps and an electric blasting machine because it is absolutely necessary to have all of the charges fired at exactly the same time.

Upon 14 beech stumps averaging about 30 in. in diameter, 27 electric blasting caps and 32 lb. of 40 per cent dynamite were used. The average cost per stump for explosives was 55 ct., in addition to which there were 6 hours of labor of the blaster and helper. The same stumps could probably have been taken out of thawed soil for about one-third less money.

## Little Giant Corner Drill

A drill designed to overcome the objection arising from the intermittent action of ratchet levers in the rotation of the spindle is illustrated. In this drill steady, uninterrupted revolution of the drill spindle is accomplished by means of a train of gears, retaining all the advantages of the ratchet type and permitting the drill to be used in the same narrow space, within 1 7/16 in. of the end wall or corner. The power of the motor is transmitted to the spindle without vibration, resulting in a steady, even pull with minimum wear and tear on the machine itself. In the stub-tooth gears which are employed, the root of the gear tooth is much thicker than in the standard involute tooth. The tooth itself is shorter, hence it has a harder pull. The special alloy steel used in these gears makes them practically indestructible. The drill is known as the Little Giant corner or close quarter drill. It is manufactured by the Chicago Pneumatic Tool Co., Chicago.



Close Corner Drill.

## Blasting Down a Brick Building

By HARRY GOUGH

The County Commissioner of St. Mary's County wanted the remains of an old brick building, three stories high with basement, torn down. The building was about 30x40 ft., with a large brick chimney at each end. There were eight fireplaces, each large enough to hold logs 4 ft. long. The building had been burned and only the brick walls were to be disposed of.

As they wished the work done quickly and as labor was very scarce, they asked me if the walls could not be blasted down with dynamite. I had never done any work of that kind before, so I decided it would be best to blast down one side of the building at a time.

I first marked off the places where I wanted the holes drilled. The holes were about 2 ft. thick. The chimneys were triangular in shape with the partition walls built into them. The fireplaces were in the corners of the rooms.

I had the holes made with a pick about half way through the wall and about 6 to 8 in. in diameter. The walls where they joined the chimneys were about 4 to 5 ft. thick and it was necessary to make the holes deeper in those sections.

I loaded three cartridges (1½ lb.) of 30 per cent dynamite in the shallow holes and five cartridges (2½ lb.) in the deep holes. The holes were spaced about 6 ft. apart along the walls. The charges were all tamped in the holes with some damp clay. Electric blasting caps were used as I desired the cumulative effect of the shots and wanted to fire them all at the same instant with a blasting machine.

After the first shot, the entire side of the building, including the chimney, was blown flat on the ground. The same method was then employed on the other sides.

We found this to be a very quick, cheap and labor-saving method of tearing down brick walls. It was only at the immediate point of the blast that the bricks were broken up much and most of them could be used again in building construction after cleaning the mortar off them the same as would have had to be done had the building been taken down by any other method.

It required but 55 lb. of dynamite and 35 blasting caps to dispose of the entire building. The caps cost about 6 ct. apiece and the dynamite about 18 ct. a pound. Two men did the entire job in a little over one day.

## Public and Private Construction Undertakings Can Now Proceed

The removal last week of the wartime restrictions on construction by the War Industries Board makes possible the immediate undertaking of a vast amount of public and private improvements. The extent of this work is indicated by articles in various newspapers, which outline the prospects in their cities. Extracts from a few of these reports are given below:

### Toledo, Ohio.

[illegible] restrictions will release outstanding county road contracts amount[illegible]

### Indianapolis, Ind.

W. W. Winslow [illegible] of the state council of [illegible] committee on building and new construction, is notifying former unsuccessful applicants for building and construction permits of the ruling announced Tuesday by the war industries board, removing in a great degree restrictions on construction projects. Mr. Winslow estimates that millions of dollars of new construction and building contemplated by private and public interests may now proceed in Indiana through the release granted by the war board. More than $15,000,000 worth of road building and maintenance may proceed again, Mr. Winslow estimated. Included in this class are also city streets, park and playground improvements. Big projects have been held up in Marion, Vigo, Lake, Elkhart, Knox, Noble, Hendricks, Putnam, Clay, Cass, Allen and other counties, but the ban against them is now off. The release of utilities improvement also will open up many millions of dollars' worth of new construction, Mr. Winslow believes. Not so many of these have been turned down by the state council or the war board, because, generally, the utilities understood the situation so well that they made no effort to begin improvements or extensions where not absolutely necessary.

### Baltimore, Md.

Specifications under which City Hall Square, at the Holliday street end of the Civic Center, will be developed were approved yesterday by the Board of Awards, and bids for doing the work will be opened one week from next Monday. It will be the first public improvement contract for the city since the surrender [illegible] through the gradual reduction in the forces at the various war plants, and will soon be in a position to resume paving operations and other new construction work. It puts a new phase on the [illegible] when the Board of Estimates is engaged in making up the municipal budget for 1919. The board has tentatively fixed the pay of city laborers next year at 40 ct. an hour. This may be changed, now that there is prospect of more abundant labor. [illegible] will be continued.

### Cincinnati, O.

[illegible] that the ending of the war, with its resultant gradual return to normal conditions, will afford an opportunity for extensive improvements in the street railway situation.

War restrictions as to man, money and materials, in addition to the lack of definite franchise authority, have held all im[illegible]

### [illegible]

Announcement came yesterday that work costing $10,000 or less may proceed at will, but that supervision by the non-war [illegible] than $10,000. This information is most pleasing to builders and building mechanics. The munition factories are expected to lay off many carpenters, masons and other building workers and opportunity to return to their trade will await them. Real estate men forecast an unusual building boom. Material is said to be as cheap now as it will be next spring. There are many completed basement foundations. The superstructure will be built when the government removes all building restrictions.

**Chicago, Ill.**

The largest industrial boom in the history of Chicago was foreseen today, following the announcement by the war industries board at Washington of the lifting of the war ban, either partially or wholly, on many of the industries essential in times of peace. Projects for which all preliminary plans had been made and finances arranged before the war started, involving the expenditure of $50,000,000 and requiring the labor of at least 50,000 men, may be started at once. Most of these are public improvement works, which have a vital bearing on the creation of Greater Chicago. Not only will they furnish employment at good wages during the critical period of reconstruction, but at the same time they mean the realization of improvements for which the city has dreamed for years. Following are the principal items together with the estimated costs, work on most of which will probably be commenced in the immediate future:

| | |
|---|---|
| Union station terminal | $10,000,000 |
| Michigan boulevard link | 6,000,000 |
| Railroad track elevation | 10,000,000 |
| New bridges in downtown district | 2,500,000 |
| Twelfth street viaduct | 2,000,000 |
| County roads | 1,000,000 |
| Blue Island pumping station | 1,200,000 |
| Sanitary district bridges | 1,500,000 |
| Ogden avenue extensions | 10,000,000 |

Removal of many drastic industrial restrictions so promptly was greeted with enthusiasm by Chicago industrial and labor leaders yesterday, because it provides time for getting the actual construction work of these immense projects under way before the unsettled transitional period from a war to a peace basis actually sets in.

## Fuel Restrictions on Clay Products and Cement Modified

In view of the increased supply of bituminous coal now available, U. S. Fuel Administrator H. A. Garfield issued an order Nov. 14 modifying the fuel restrictions put upon the manufacture of different clay products by an order issued April 13, and also the restrictions on the consumption of fuel in the manufacture of cement, by an order dated Aug. 8.

The order reduces the percentages of curtailment as defined in the orders of April 13 and Aug. 8, one-half in every case. For example, the industry that was curtailed 50 per cent is now permitted to burn 75 per cent of the fuel consumed during the years 1915, 1916, and 1917. Plants that were restricted to 75 per cent are now allowed to burn 87½ per cent of their normal requirements, and in the case of stoneware manufacturers who were restricted to 85 per cent they may now burn 92½ per cent of normal requirements.

The partial withdrawal of the restriction is in line with the policy of the War Industries Board and the restrictions still in force are maintained in accordance therewith.

The percentages of curtailment which are continued in force are as follows:

| | Per Cent. |
|---|---|
| Cement | 12½ |
| Face Brick | 25 |
| Common Brick | 25 |
| Paving Brick | 25 |
| Terra Cotta | 25 |
| Roofing Tile | 25 |
| Floor and Wall Tile | 25 |
| Sanitary ware | 25 |
| Hollow tile | 12½ |
| Drain tile and sewer pipe | 12½ |
| Stoneware (except [illegible]) | 7½ |

## Personals

**Fullerton P. McGough**, of Pittsburgh, Pa., has been appointed division engineer of the Baltimore & Ohio R. R., with headquarters at Grafton, W. Va.

**W. A. Mather**, superintendent of the Canadian Pacific Ry. at Vancouver, B. C., has been promoted to the position of general superintendent of Moose Jaw.

**Harry A. Nicholl**, general manager of the Union Traction Company of Indiana, has been appointed federal manager of transportation for the Hampton (Va.) District.

**C. E. Ashcraft**, formerly connected with the Pittsburgh office of the U. S. engineers, with the local United States engineers, has been appointed general superintendent of the Baker, Dunbar, Allen Co., with offices in Philadelphia.

**Edgar A. Rossiter**, formerly Major Engineers, U. S. R., stationed at the Engineer Depot, Washington, as purchasing officer waterworks supplies and equipment, has returned to his private practice at 522 Reaper Block, Chicago.

**C. P. Richardson** has been appointed cost engineer for the Davenport, Iowa, project of the United States Housing Corporation. He formerly was assistant engineer of track elevation for the Rock Island Lines with headquarters at Chicago.

**Albert Larsen**, of Milwaukee, Wis., has been appointed division engineer on railway work by the Miami conservation district, Dayton, O. In this capacity, he will have charge of the activities incident to the railway re-location and all other operations pertaining to railways within the district.

**Colonel John Millis**, U. S. Corps of Engineers, who has been in charge of the southeast engineer division, which includes Jacksonville, Fla., has been transferred to the central department, with headquarters at Chicago. Colonel F. W. Aelstetter has been assigned to the position made vacant by the transfer of Colonel Millis.

**Elmer E. Strong**, superintendent of transportation of the New York State Rys., Rochester Lines, since 1913, has resigned to enter business for himself, as an associate of Henry J. Schiefer & Company, district engineers and sales representatives in Central and Western New York for high tension and power apparatus, with offices at 312 Ellwanger and Barry Building, Rochester, N. Y. He is succeeded by Roy R. Hodsell, at present assistant superintendent.

**C. Nesbit Duffy** has resigned as vice-president of the Manila Electric Railroad & Light Co., Manila, P. I., to accept the position of vice-president of the Visayan Refining Co., Manila, P. I., one of the largest cocoanut oil companies in the Philippine Islands. Mr. Duffy took over his new duties on Nov. 1. J. C. Rockwell, the present general manager of the Manila Electric Railroad & Light Co., has been placed in full charge of the affairs of that company in Manila by The J. W. White Management Corporation, New York, N. Y., the operating managers of the property.

**H. L. Treeman** has been promoted by The J. G. White Management Corporation, New York, from industrial engineer of that organization to the position of manager of the electric department of the Eastern Pennsylvania Railways Co. and the Eastern Pennsylvania Light, Heat & Power Co., of Pottsville, Pa. Both of these utilities are operated by the management corporation. Mr. Treeman was graduated from Oklahoma Agricultural & Mechanical College in 1909, with the degree of bachelor of science, having specialized in mechanical and electrical engineering. He was associated with the Edison Electric Illuminating Co. of Brooklyn as power engineer for a number of years. In 1915 he left the services of that company to accept the position of industrial engineer with The J. G. White Management Corporation.

**B. Powell Harrison**, engineer of the State Roads Commission of Maryland, has been appointed harbor engineer of Baltimore, Md., succeeding H. Kent McClay, who resigned to enter the service of the United States Navy. Mr. Harrison is a graduate of the Virginia Military Institute; was employed on the Panama Canal three years; was engineer in the construction department of the Baltimore & Ohio R. R. for two years; resident engineer 3 years and was assistant engineer for 2 years. He was engaged on the filtration plant at Washington for 2 years and was engineer in charge of dredging and survey work on Patapsco River and Chesapeake Bay for 4 years, or until 1912. Since then he has been division engineer, second assistant engineer and first engineer of the State Roads Commission until the present time.

## Obituaries

**William Saint**, a contractor of Dayton, O., died Nov. 6, aged 81.

**Thomas L. Campbell**, a railroad drainage contractor of Topeka, Kan., died Nov. 10.

**J. Robert Goetzman**, an engineer with Chester & Fleming, consulting engineers, Pittsburgh, Pa., died recently at Louisville, Ky., aged 27.

**John T. Hueter**, a contractor of Spokane, Wash., died Nov. 10 from injuries sustained in a fall from a flour mill that he was constructing at Cheney, Wash.

**James C. Hallock**, formerly deputy chief engineer of Newark, N. J., in which position he had charge of the meadow reclamation work and general development of the Port of Newark, died Nov. 2 in Ecuador, where he had gone last February to become engineer to that republic, with his chief task to be suggestions of a system to curb the annual floods in the River Jubones and end this serious menace to the chocolate plantations.

**Leonard S. Cairns**, general manager of the Eastern Pennsylvania Railways Co., died of pneumonia on Oct. 10 at Pottsville, Pa. He was 36 years of age. For a number of years Mr. Cairns was general superintendent of the Twin City Rapid Transit Co. of Minneapolis and St. Paul, Minn. In 1912 he resigned from the operating organization of that company to join the staff of The J. G. White Management Corporation, New York, N. Y., and was assigned to the position of assistant general manager of the Manila Electric Railroad & Light Company, Manila, P. I. He was promoted by the management corporation in 1917 to the office of general manager of the Eastern Pennsylvania Railways Company, Pottsville, Pa.

**Albert A. Robinson**, formerly vice-president of the Santa Fe Ry. and president of the Mexican Central Ry., died Nov. 7 at his home in Topeka, Kan. He was born in South Reading, Vt., in 1844, and was graduated from the University of Michigan in 1869. He entered the engineering department of the St. Joseph & Denver City Ry. the same year. In April, 1871, he entered the service of the Santa Fe, which road was then scarcely 100 miles long. When he left the system twenty-two years later the "road" had grown into a system of more than 9,000 miles in extent. More than half of this system was built under his direction. His first work with the Santa Fe was on surveys and construction between Topeka and Atchison. He was made chief engineer in 1873 and later held the following positions in the succession that they are given: Division superintendent, superintendent of bridges, building and water service, assistant general superintendent, general manager, second vice-president, vice-president and general manager. In May, 1893, he resigned to become president of the Mexican Central Ry., which position he held until his retirement in 1906.

*Building and Structural Issue*

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**Roads and Streets—1st Wednesday**
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies

**Waterworks and Hydraulics—2nd Wednesday**
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power

**Railways and Govt. Works—3rd Wednesday**
(a) Excavation and Dredging
(b) Rivers and Canals
(c) Harbors and Docks
(d) Railway Construction

**Buildings and Structures—4th Wednesday**
(a) Buildings
(b) Bridges
(c) Ship Construction
(d) Miscellaneous Structures

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# A New Method of Testing Iron and Steel by Which Internal Defects and Nonhomogeneity Are Disclosed

As far back as 1896 physicists began publishing the results of "magnetic tests" to determine the relative uniformity of iron and steel bars. Within the last few years "magnet testing" has received increasing attention, and the U. S. Bureau of Standards has developed simple and effective electrical apparatus for the purpose.

Flaws and non-homogeneities that would be fatal are now discoverable. It is therefore safe to predict that before many years structural engineers will be specifying the "magnetic testing" of all important members of steel bridges, buildings, etc. No longer will it be considered economic to insure safety by the use of high factors of safety.

At the last meeting of the American Society for Testing Materials, Prof. M. A. Howe spoke of "magnet testing" as being in its infancy, and the implication was that engineers need not yet give it serious consideration. But it is already a pretty lusty infant, and one that no professional engineer can longer afford to ignore.

In a bulletin of the Bureau of Standards, Raymond L. Sanford, Assistant Physicist, gives some very interesting charts of magnetic tests on iron and steel bars, his paper being entitled "Determination of the Degree of Uniformity of Bars for Magnetic Standards." He also describes the testing instrument (an electromagnet, galvanometer and coils) and the theory of its operations. We quote:

> From leakage data taken at equal intervals along the length of the bar the ordinates of the [illegible] curve are calculated, and these points are plotted against displacement along the bar.
>
> A continuous record of the whole length of the bar is possible by a modification of the apparatus. If the [illegible] coils are moved at a uniform rate along the bar, the emf induced is proportional to the rate of change of leakage along the bar. This emf is constant for a uniform bar and variations indicate non-uniformities. It is possible with suitable apparatus to obtain a photographic record showing the degree of uniformity along the length of a bar.
>
> Tests have been made on a large number of bars to determine the degree of magnetic uniformity that may be expected in ordinary test bars as received and also to determine the magnitude of the effect of non-uniformities on the accuracy with which magnetic measurements can be made.
>
> The curves of cast-steel bars all show large deviations from [illegible] material that gives trouble is wrought iron, which in general is [illegible] curves also show large deviations and indicate extremely inhomogeneous material.
>
> [illegible]

Although it may be several years before "magnet testing" will be generally specified by structural engineers, it [illegible] to study all that the physicists have already accomplished. Moreover, it may be that the "magnetic testing" of hoisting cables, chains, hooks, etc., should be initiated at once wherever an accident might cause death or injury to human beings. Every little while a steering rod of an automobile breaks, and deaths result. It would appear that such accidents are now preventable, for the electromagnet and galvanometer furnish a simple means of looking, as it were, into the interior of steel parts of machines and structures and discovering any flaw or lack of uniformity. As is well known to engineers, nearly all failures of well designed steel members are due to defects not apparent externally. At last we are accurately measuring homogeneity. We engineers, shall be derelict indeed if we do not take up immediately and perfect the magnet method of testing steel which the physicists have already done so much to make practical.

## "Peace Will Be Followed by a Huge Construction Program"

In a recent contribution to the Wisconsin Engineer Maj. James F. Case, chief engineer of the American International Corp., said:

> The present world struggle is a war of engineering, and though its object is destruction, there is much to be learned and applied to constructive effort in normal times. First of these is the problem of transportation, and in this field I believe you will find a great opportunity for the engineer. Due to high construction costs and unsettled financial conditions, railroad work has been confined to maintenance essentials, and no new construction has been undertaken. Existing lines have been overtaxed, and congestion has resulted. Peace will certainly be followed by a huge construction program, and engineers will be in demand. Furthermore, the United States has at last turned its attention to overseas transport. We are now building ships on an unprecedented scale and by revolutionary methods. The plan of quantity production of standardized fabricated ships is purely the development of the American engineer. With it must come harbors, docks and yards, terminals and cargo handling methods, all of which bring countless opportunities to the profession.

Maj. Case voices the opinion of most civil engineers in predicting an era of intensive and extensive construction following the close of the war. But engineers should not quietly wait for things to happen; they should bring their whole organized effort to bear in hastening the beginning of a construction boom. Thousands of engineers and millions of soldiers will soon be back from Europe, and they will expect us to have planned useful work for them to do. Are we planning it now? Are we going before city councils, Congress and other legislative bodies asking for adequate appropriations for public works? Or are we sitting around waiting for George to do it? We put these questions to every one of our readers as well as to all engineering societies and clubs. Civil engineers, above every other class of men, are best able to advise the public how and where to expend money judiciously. Let us not wait for less well informed men to lead the movement for post-bellum public works. Ours is by right the leadership. Let us lead.

## Should Not Milk Be Distributed by Public Service Companies?

Excessive competition is one of the main causes of high retail prices of food and clothing. But there seems to be no practical way of reducing such competition except through Government intervention of some kind, and that involves some degree of Government regulation of prices. The late Mayor Mitchel of New York appointed a committee that made a report early this year on the cost of milk, with suggestions of ways of reducing both the cost and the retail price. The committee said:

> Either the municipality itself might undertake the distribution or the companies engaged in distributing milk should be regarded and regulated as public service corporations. And just as now one particular water supply corporation is granted a franchise for a certain territory, so the distribution of milk in a given territory might be restricted to one corporation or to a single delivery agent of the combined distributing companies. Such centralization appears inevitable.

The committee pointed out that in Ottawa three-fourths of the milk business is in the hands of one firm, which operates on a margin of 3.25 ct. a quart above the wholesale cost; whereas the same margin in New York City is 7 ct., or more than double that in Ottawa. In New York, Connecticut and New Jersey, according to the committee, milk was produced by the farmers in 1917 at a cost of 6.7 ct. per quart where each herd numbered only 7 to 10 cows, as against 4.7 ct. where each herd numbered 50 cows.

These cost data seem to indicate that milk could be produced and sold in New York City for 8 ct. a quart instead of 13 or 14 ct., provided economic methods were applied both in producing and in delivering the milk.

Evidently there is a field for the application of the principles of engineering economics in the milk business. If as much engineering science had been devoted to that business as to the generation and distribution of electricity, for example, we should today have milk at half the price we now pay for it.

One of the greatest and most pressing problems in political economics is so to restrict competition and coincidently develop enterprise and the application of science to secure as great economic efficiency in food production as we have already secured in the production of electricity. As engineers have accomplished the latter, may it not be engineers who will also accomplish the former?

## The Architect versus The Engineer

It is the firm belief of almost every successful man that he has escaped the common fate of being narrow minded. Akin to this belief of the successful individual is the high regard with which most professional men view the training they have had. The lawyer regards his legal training as one that peculiarly fits him to look upon the world in no narrow manner. So does the theologian, so does the doctor, so does the chemist, so does the architect, so does the engineer. But, for some peculiar reason, each profession is prone to regard the other professions as being one-sided or narrow.

Not long ago C. H. Blackall, writing in the American Architect, complained that architects had not been given a leading part in war work. He rebelled against the fact that structural engineers had designed nearly all the buildings for Government war purposes, and that the architect had been so completely ignored in his own specialty —building design and construction. He denounced the popular conception that an architect is merely an artist, "that his chief interest is in making pictures," and that business has nothing to do with him or he with business. He said:

> He is not the "builder of arches" but the "arch technician," or, to use the modern phrase, the master builder. His function is to do and plan things in an orderly sequence and with a consideration for all the factors which enter into a complete structure, of which, very naturally, the artistic appearance may be beyond question an important one, but is not of itself sufficient, and, except in rare cases of monumental design, is really a by-product rather than a dominant factor. He differs from the engineer in that he is not to be one-sided, not to consider mere efficiency nor mere program, nor mere so-called practical factors, but is to take all of these plus the fundamental principles of order, purpose and fitness; and if they are properly combined then the creative element of pure design will result just as inevitably as it did in the west front of Amiens or the north porch of Chartres.

We are not disposed to criticise this ideal picture of what an architect supposes himself to be—all that the "one-sided engineer" is, plus "order, purpose and fitness." However, the world has a way of weighing professions by what they do rather than by what they profess to do. The engineer is both a designer of structures and an economist. Economics is his specialty, even as art is the specialty of the architect. Hence when the war suddenly presented problems of building design and erection in which economy of time was paramount the nation turned to its structural engineers and not to its architects. No one asserts that the engineers failed to meet the emergency. These "one-sided engineers" were just one-sided enough to know that one side from end to end and across the middle. They did all and more than was expected of them, but, if we are to believe Mr. Blackall, they somehow achieved the result despite their defective sense of "order, purpose and fitness."

Human knowledge is now so vast in its aggregate and human skill so varied that it is pure self-delusion for any class of men to fancy that theirs is a truly broad profession, if by "broad" it is implied that more than a modicum of the total knowledge and skill is to be found within its confines. The architect is no more "broad" than the engineer. Each is a specialist as every successful man today must be. By giving slight attention to art and a great deal to structural economics, an architect may rival a structural engineer as a designer of industrial buildings, but not otherwise. Conversely, if an engineer will subordinate the study of economcs to that of art, he may aspire to become celebrated for the beauty of his buildings or bridges; but coincidently he must be content to rank inferior to other engineers as a specialist in structural economy.

Vain is the hope, and vain the man who indulges it, that he can be at once the equal of any specialist in a given line and at the same time be a composite specialist in several lines.

Let us close with another quotation from Mr. Blackall:

> There will always be building so long as mankind is a gregarious animal. There will also always be a consideration given to the more artistic qualities which the race incorporates in its monuments and which constitute the true historical record of the age. The question we are interested in as a profession is as to who is to be the directing force in this building work. Will it be the master builders, as they are now known? Will it be the engineers, who are [illegible] now, or will the choice be from the profession which has striven and aspired, written codes of ethics, and taken position on pedestals, beneficently arrogating prominence in constructive arts, and speaking ex cathedra on every occasion, only to find that consideration is no longer an inevitable appanage? It is really a pretty serious question for us. No man is likely to have the whole truth revealed to him, and none of his reasoning from finite experience and limited vision can hope to answer all of the questions; and yet it hardly seems possible that the architect of four years ago will have much consideration four years hence, unless he changes very fundamentally.

## Discharge the Capital Issues Committee and Give Cities and States a Chance to Sell Public Works Bonds

The War Labor Policies Board on Nov. 20 asked the mayors of the principal cities to make arrangements for starting as many public work projects as possible. The board requested that its nearest office be notified by each town as to the number of men that will be needed.

This is the first important step that the federal government has taken toward providing public work for the men who will soon be out of employment. But lack of knowledge of the general nature of municipal construction is indicated by the naive request that each mayor state how many workmen will be needed. Here it is that the civil engineers of America should come at once to the assistance of the War Labor Policies Board, telling the board in detail what must be done preliminary to estimating the number of workmen that will be required. First, each city must formulate a general policy as the total expenditures for construction and maintenance in 1919. This can not be the work of a moment. In many cases it will involve special elections to provide for the issue of bonds.

At the very moment that the War Labor Policies Board is asking cities to provide extensive appropriations for public works, another federal board, the Capital Issues Committee, is telling the public that bond issues for public works must be curtailed, or at least sidetracked, in order that the federal government may float some eight billions of war bonds! A pretty mixup, isn't it? Men being thrown out of work, public appropriations necessary to give employment, and the Capital Issues Committee sitting on every appropriation lid so that the coming "liberty loans" shall be fully subscribed!

Engineering societies should lose no time in protesting against any further restriction of public works bond issues by the Capital Issues Committee. In fact, the time has come to discharge that committee. Uncle Sam is big enough to look after himself in the competition for funds in the capital markets. Let the cities, counties and states have a chance to get the money they sorely need if they are to do their part in giving useful work to the returning soldiers.

## Production Control in Shipbuilding

Production control may be defined as a means of directing manufacturing effort toward certain well defined ends. As applied to shipbuilding, it means the co-ordination of effort of the various departments of the organization to bring together at the right time the parts going into the completed structures. The application of production control to shipbuilding is discussed in one of the standard practice bulletins issued by the Division of Steel Ship Construction of the U. S. Shipping Board Emergency Fleet Corporation. The following notes are taken from that bulletin.

The chart, Fig. 1, shows a typical shipyard organization. On this chart the administrative functions are represented by the general manager, office manager, purchasing agent, head of engineering department, head of employment office and, under certain conditions, the works manager. The operative functions are represented by the works manager and the heads of all departments responsible to him.

Production control is partly administrative and partly operative in that it is concerned with the engineering department, purchasing agent and production engineer. The engineering department is charged with material requirements and production requirements which it passes on to the purchasing agent and production engineer respectively. The purchasing agent purchases materials and upon receipt notifies production engineer, who is then in a position to release production schedules affecting such material and in accordance with production requirements. That the control of production through production schedules may be effective, it is logical that production records should go to the production engineer, otherwise too much or too little work might be released resulting in congestion or idleness in the shop. In other words, these records are necessary to maintain a proper balance and a uniform flow of material through the shops.

From the receipt of production schedules in the shops production control really ceases and output then becomes a matter of operating conditions and is under direct supervision of the shop executives.

The underlying basis of production control is segregation of duties and responsibilities such that each unit or individual of the organization has a certain part to perform, each part bearing a definite relation to the whole, as well as to the other parts. To make this control effective in practice it is necessary to provide some means of transmitting information or instructions between departments. This is usually accomplished by the use of printed forms, properly designed as a result of a study of conditions to be met. Such forms are the outward and visible signs of "systems" in use and should be as simple as consistent with needs. Properly worked out they save an immense amount of confusion and delay and tend toward making every-day activities more or less automatic, thereby relieving executives of unnecessary detail and generally simplifying the conduct of the business. In addition they furnish data for record and use for cost accounting, statistical and production purposes, but, most important of all, they take the place of "word of mouth" methods.

As tending toward a clearer conception of production control through an organization such as represented by Fig. 1, assume that a contract has been received. This contract will be followed through step by step in sufficient detail to show relations of departments to each other in the control of production and how such control is largely a matter of organization.

A contract having been secured, it is promulgated by an order from the general manager to the engineering department. This order should be in writing, preferably on a prescribed form, containing information as to type, tonnage, specifications, contract number, owner, time of delivery and such other information as may be necessary to a thorough understanding of all general conditions and to identify the contract throughout the plant. The preliminaries to a contract involve more or less estimating by the engineering department on matters of cost, specifications and design, hence the promulgating order by the general manager need not go into these details.

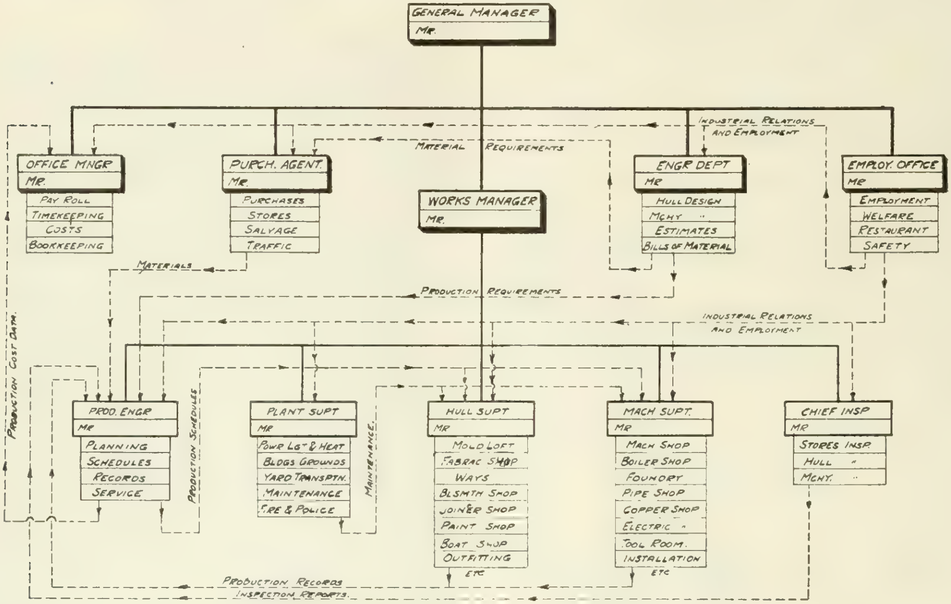

Fig. 1—Typical Shipyard Organization.

The engineering department completes drawing details to the extent necessary, in the meantime making up bills of material of known requirements which are forwarded to purchasing agent in order to place mill orders with the least possible delay. As detail drawings are completed supplementary bills of material are forwarded to purchasing agent until all material is ordered, when dealings between these two departments end as far as this particular contract is concerned. As a general rule, the purchasing agent is dependent on the engineering department for all bills of material, whether furnished as above outlined or complete before placing mill orders.

Blue prints to the required number are made by the engineering department and distributed through the production engineer to the department concerned. These usually are subdivisions of the ship made up to show details of assembly and, in many cases, the sequence of erection. Charts compiled from these drawings showing material requirements of each subdivision, commonly called "breakdowns," are made up in engineering department and distributed through production engineer to departments concerned.

The purchasing agent places mill orders in accordance with bills of material received from the engineering department. Whether or not this material is ordered for delivery in the sequence desired depends entirely on instructions accompanying bills of material. Presumably this is always done, but, in any event, the purchasing agent is responsible for all follow-ups on deliveries. He is charged with the stores function which implies notification to the proper departments of receipt of material which can then be placed in production. The stores function includes general stores as well as raw material for construction purposes.

The purchasing agent is responsible for keeping track of all material ordered prior to its delivery and should have under him a properly qualified traffic man, whose duty would be to trace all material, direct outside stock or material purchasers and by every possible means attempt to secure delivery of material as promised or wanted.

The production engineer is the heart, the general and works managers, the brains and the other executives, the nerve centers controlling actual operations. It is therefore logical that instructions governing actual manufacturing operations should originate with the production engineer, which implies that all orders concerned therewith should clear through his department. That an intelligent record of performance may be kept, it is also logical that reports of accomplishment should come to him. He is particularly concerned with the "systems" in use, as through them he is enabled to issue orders and furnish data for the proper conduct of the business. If the systems in use have been properly worked out and applied only the minimum amount of clerical work will be required in the production centers or shops proper. This will be done in the production engineer's department, where provision is made to take care of it. By reducing shop clerical work to a minimum it is obvious that shop executives and supervisors can concentrate on work in hand, which is their legitimate function.

The production engineer is not given any authority over departments other than his own. Instructions issuing from his department covering production activities have back of them the authority of the works manager in particular and the management in general, due to the type of organization in effect. Adjustments with other department heads are made through the works manager if necessary.

# Reinforced Concrete Slab Bridge Design Based on Tests of Full Size Slabs

Practical rules for applying results of tests of full size reinforced concrete slabs in the design of bridges are given by Mr. A. T. Goldbeck, Engineer of Tests, U. S. Bureau of Public Roads, in the September issue of Public Roads. The matter following is abstracted from the above mentioned publication.

**Method of Testing Slabs.** In all of the slab tests at the Bureau of Public Roads the method of procedure was to apply known concentrated loads on the slag specimens which rested on two supports. The deformation of the steel reinforcing and concrete, and also the deflection were measured. These deformations or changes in length in the slab were always taken at the "dangerous section," where they were greatest. In a few cases, deformations were also measured over the entire area of the slab. A strain gag capable of measuring changes of 0.0002 of an inch was used in all of the tests, and in addition, the vertical deflections of the slab were obtained, generally by means of a micrometer head reading to 0.001 of an inch.

**Theory of Application of Results of Tests.**—Consider first a wide slab supporting a single load concentrated at its center. The maximum deformation occurs under the load, and as the sides of the slab are approached the deformation becomes smaller.

This curve of deformation is the same in shape for both the steel and concrete. The resisting moment of any slab is directly proportional to the area of the curve of unit deformation. Two similar slabs stressed to have the same area of unit deformation, even though their unit deformation curves are dissimilar in shape, exert equal resisting moments. The effective width of the slab is the width which may be considered as carrying the entire concentrated load. When the value for this width as determined by test is substituted in the common formulas for narrow rectangular beams, these formulas may be directly applied to the design of wide slabs.

A number of slabs have been tested as outlined above, and their effective widths have been obtained from the deformation curves, first, by getting the areas included between these curves and their base lines, then dividing these areas by their maximum ordinates. When the load is placed in the centers of the slab and the width of the slab is more than about twice the span length, the effective width may be considered as equal to seven-tenths of the span length of the slab.

A number of slabs have been tested with a central load and having width equal to twice their span lengths. Table I gives data on the slabs tested at the Bureau of Public Roads during the past 5 years.

**Slabs Having Widths Less than Twice Their Span.**—The foregoing discussion treats of slabs having widths equal to twice the span length, in which case the sides of the slabs are not stressed appreciably. When the width is less than this, however, stress does reach the sides, and the narrower the slab, the more are the sides put under stress. It will be recognized that the width of the slab plays an important part in influencing the effective width. The amount of this influence has been quite fully investigated by a number of slab tests, in which the width of the specimen has been decreased after each load application, the sides of the slab having been split off by means of plugs and feathers. It has been possible to obtain from these investigations the values for effective width given in Table II. These values also are plotted in Fig. 1.

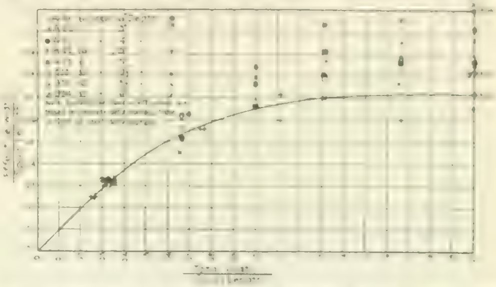

Fig. 1—Influence of Total Width on Effective Width of Reinforced Concrete Slabs Subjected to Concentrated Loading.

TABLE II—VALUES FOR EFFECTIVE WIDTH

| Total width ÷ span | Effective width [illegible] |
|---|---|
| 0.1 | 0.1 |
| 0.2 | 0.2 |
| 0.3 | 0.28 |
| 0.4 | 0.37 |
| 0.5 | 0.44 |
| 0.6 | 0.50 |
| 0.7 | 0.55 |
| 0.8 | 0.58 |
| 0.9 | 0.62 |
| 1.0 | 0.65 |
| 1.1 | 0.67 |
| 1.2 | 0.68 |
| 1.3 | 0.70 |
| 1.4 | 0.71 |
| 1.5 | 0.72 |
| 1.6 | 0.72 |
| 1.7 | 0.72 |
| 1.8 | 0.72 |
| 1.9 | 0.72 |
| 2.0 | 0.72 |

The above values may be used for spans up to 16 ft. at least, and probably for longer spans.

**Two loads on the Slab.**—When the span is such that a single axle load will control the maximum bending moment, the slab is subjected to two wheel concentrations, and the most dangerous condition exists when these wheels are midway between the supports. In order to investigate this condition, tests were made on slabs with two loads spaced 5 ft. apart on the center line of the slab.

Note the fact that directly under the load the deformations are greatest, and are even slightly greater than the deformation at the center of the slab. This stress distribution does not hold, however, for every thickness of slab, for a few of the tests show the deformation to be greatest at the center. The effective width of slabs loaded in this

TABLE I—DATA ON SLAB TESTS OF BUREAU OF PUBLIC ROADS

| Slab No. | [illegible] Span Feet | [illegible] Breadth Feet | —Depth. Total In. | Effect[illegible] In. | —Steel percentage.— [illegible] | [illegible] | [illegible] width | [illegible] | Central load |
|---|---|---|---|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | 7 | [illegible] | [illegible] | [illegible] | | [illegible] | 21,500 |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | 0.9 | | |
| 706 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.4[illegible] | | [illegible] | 42,800 |
| [illegible] | | [illegible] | 6 | [illegible] | [illegible] | [illegible] | 1.1 | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 7,560 |
| [illegible] | [illegible] | | [illegible] | [illegible] | | [illegible] | 1.2 | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | 16 | 80,000 |
| [illegible] | [illegible] | [illegible] | 7 | 6 | [illegible] | [illegible] | [illegible] | [illegible] | 40,000 |

[illegible]

EFFECTIVE WIDTHS UNDER CENTRAL LOADS

| Center load | Slab [illegible] effective depth | Slab [illegible] effective depth | Slab [illegible] effective depth |
|---|---|---|---|
| 15,000 | | 11'[illegible]=71.6 per cent span | 12'.7=[illegible] per cent span. |
| 20,000 .. | 11'.8=[illegible] per cent span | 1[illegible]=81.2 per cent span. | 17'.5=109.3 per cent span. |
| 25,000 .. | 11'[illegible] per cent span | 12'.9=81.1 per cent span. | |
| 32,500 .. | 12'.1=[illegible] per cent span | | |
| 35,000 .. | | 11[illegible] per cent span | |
| Failure | [illegible] lb. | 80,000 lb. | 40,000 lb. |

way may, in general, be assumed as equal to the effective width due to a single load plus 4 ft.

**Eccentrically Loaded Slab.**—When a heavy load traverses a slab bridge it may not remain at the center line, but may travel over the bridge near one side. Again there are often occasions where a heavy traction engine will stop at the side of a bridge spanning a stream, in order to replenish its supply of water. On such occasions heavy load concentrations are supported on the side of the bridge as eccentric loads, and this is a much more severe condition than that of the centrally applied load.

For the investigation of this case a slab specimen 16 ft. in span, 32 ft. in width and 13 in. effective depth was made up. The original width was decreased after each test by cutting strips off of one side. The load applied in the center of the original 32-ft. width became an eccentric load as the side of the slab was gradually removed. Referring to Fig. 2, the strips ij, hi, gh, fg, ab, bc, cd, and de, were split off in the order named. The load was always applied to the same spot and thus its eccentricity varied as the slab width was decreased. Without going into the details of the test, the results are shown in the curve in Fig. 2. The dash line curve is merely a duplication of that in Fig. 1, and applies to wide slabs under a central load. The solid curve is based on the tests of the eccentrically loaded slab. About 10 ft. were split off the sides of the slab before the effective width began to differ from that of the centrally loaded slab. The load was then 6 ft. from the side of the slab, and when its distance to the side became less than this, the effective width became much less than that of the same slab centrally loaded. This is shown by the deviation of the solid line from the dash line. The dotted line is plotted to represent the effective width of an eccentrically loaded slab with values for this effective width assumed to be equal to $\frac{b_c}{2} + D$, where $b_c$ = the effective width of the slab under central load. D = distance of load to nearest side of slab.

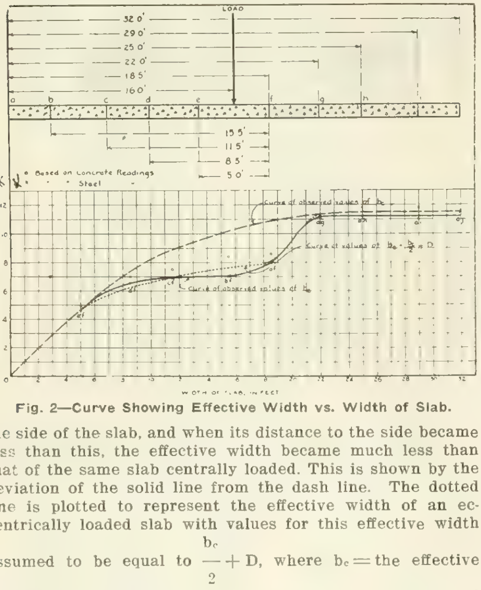

Fig. 2—Curve Showing Effective Width vs. Width of Slab.

This curve follows the curve of test results very closely and it may be quite safely stated as a general proposition that when a slab is eccentrically loaded, the effective width to be used in design may be calculated in the following manner:

(1) When the distance of the load from the nearest side is more than half of the effective width of the centrally loaded slab (Table II) use the effective width for central loads.

(2) When the distance of the load from the side of the slab is less than half the effective width under central loads (Table II) the effective width is to be taken equal to $\frac{b_c}{2} + D$. In order to make a slab bridge eccentrically loaded equal in strength to one centrally loaded, it will be necessary to supply extra strength at the sides by means of a parapet wall, and the following procedure for the design will give safe results:

(1) Use the formulas for narrow rectangular beams substituting for the breadth b the value obtained from Table II, (2) determine the loss in effective width due to the assumed eccentricity of the load, (3) supply the deficiency by designing the curb of the parapet to provide a resisting moment equal to that of the slab width lost due to eccentricity. Allowance will have to be made, however, for the stiffness of the section under the parapet. An unfinished test thus far indicates that this method of design is safe at least.

To illustrate the above method. Assume the slab 16 ft. in span length and 20 ft. in width, designed to carry a concentrated load to be applied 3 ft. from one edge, then the

$$\frac{\text{Total width}}{\text{span}} = \frac{20}{16} = 1.25.$$

From the table for central concentrated loading (Table II), the effective width = 0.69×16 ft. = 11.04 ft. = $b_c$. Consider the load to be carried by a width of 11.04 ft., use the ordinary formulas for rectangular beam design, and determine the effective depth of the slab and the area of the steel required. Next determine, by the relation indicated above, the effective width with the load placed 3 ft. from the side.

$$b_e = \frac{11.04}{2} + 3 \text{ ft.} = 8.52$$

ft. = effective width for eccentric load.

The difference between the values of $b_c$ and $b_e$ is 11.04 — 8.52 = 2.52 ft. The curb of the parapet should, therefore, be designed so that it will have a resisting moment equal to that of a slab of width 2.52 ft.

Although there are several other conditions which may arise in the investigation of bridge slabs, the few above considered are most important, as they generally control the design.

## Opportunities in the Management Engineering Field

It is the writer's belief that opportunities today for the technically trained engineer have never been equaled. This is true of the technical engineer, not only for purely engineering position, but for the larger field of management. The honest and broad-minded engineer is being continuously demanded for responsible positions in most lines of industry. With the engineer's technical training, which tends to develop the ability intellectually and economically to solve operation, maintenance, and construction problems applicable to almost every kind of industry, and with his capacity for handling men, he can and does today fill many very responsible positions involving constructive management.

To be permanently successful, every line of large industry needs economical management which the technical engineer, after he has rounded his career with a business training, is better able to give than most other professional men. A business training, resulting in the development of a sound judgment, is an essential factor in the career of nearly every successful man, and it is my belief that capable engineers with sound judgment today have more and better opportunities to advance to prominent positions and go even to the top of their industry than heretofore. Those who have control of industry recognize, more than ever before, that the physical conditions and the net results of their business depends mainly upon good executive management, and that managership positions are better filled by technically educated men than otherwise. Without question most men with an engineering education for a foundation will succeed in the world of affairs, if they have a liking for mechanical work, a love for doing things—accomplishments—and a proper share of "stick-to-it-iveness"—perseverance.—Ray Palmer, president of the New York & Queens Electric Light & Power Co., of New York, in The Wisconsin Engineer.

# Mechanical Features of Vertical-Lift Bridges*

By HORATIO P. VAN CLEVE
Chief Draftsman, The J. Edward Ogden Co., New York.

The first important vertical-lift bridge was built in 1892 over the south branch of the Chicago River, at Halsted St., Chicago. Its span is 130 ft., it provides for city-highway and electric-railway traffic, and lifts 140 ft., affording vertical clearance for boats of 155 ft. This bridge is illustrated in Fig. 1.

The dead load is counterbalanced by a set of weights connected to the lift span by wire ropes which pass over grooved sheaves on the tops of the towers. The operating machinery is located under the roadway, at the base of one of the towers, and the power is transmitted by a system of wire-rope drives, running from the grooved drums in the machinery house to each end of the lift span, and to each counterweight. There are 16 ropes in all. Eight up-haul ropes, passing around a set of idlers at the bottom of the near tower, are carried to its top, where they divide into two groups. Four turn downward over another set of sheaves and attach to the near end of the lift span, and four, running horizontally to the top of the far tower, are there deflected downward and attach to the far end of the lift span. The eight down-haul ropes are connected in similar manner to the tops of the counterweights.

The towers, 217 ft. high, are steadied by well-braced lattice girders, which serve also as a support for the idler sheaves placed midway between towers to guide and steady the horizontal reaches of the operating ropes.

In the second structure of this type, of 229-ft. span and 40-ft. lift, built in 1909 across the Mississippi on the line of the Iowa Central R. R., near Keithsburg, Ill., several improvements were made on the operating mechanism of the Halsted St. bridge. Chief among these was the change in the location of the machinery from the pit below the tower to the top of the lift span. This shortened materially the length of operating ropes and reduced to a minimum the complications in their connection and arrangement; and it put the operator at once in reach of his machinery and in view of the river and approaching trains.

The scheme of operation, that used on nearly all succeeding lift spans, is as follows: The motor, in this case a gas engine, is connected by a train of gears to four spirally grooved operating drums, two over each top chord. Two operating ropes are fastened by rope clips to each of these drums, one for the upward movement of the span and the other for the downward, and are so wound on the grooves of the drum that the up-haul rope is wound on while the down-haul rope is paid off, and vice versa. An up-haul rope runs from each drum to the corresponding corner of the lift span, there over a double-grooved deflector sheave, and thence to the top of the tower, to which it is connected. The down-haul rope parallels the up-haul as far as the deflector sheave, and there, passing downward over the other groove in the latter, connects to the tower at a point in convenient reach of the deck.

Rotation of the drums in one direction winds up on the up-haul ropes, causing an upward force at the deflector sheaves and thus, overcoming the friction of the tower sheave journals in their bearings, the unbalanced weight of suspending ropes and the inertia of the moving parts, lifts the span. All four of the operating drums are locked together by the connecting gearing, thus insuring the synchronous rotation of the sheaves and keeping the span at all times parallel to its original position.

To keep the span in proper alignment between the towers, vertical tracks are provided on the four tower legs adjacent to it, and on these tracks bear the rollers which hold the span both in transverse and longitudinal alignment. Wedge-shaped steel castings at the foot of each tower engage close-fitting mating castings on the span when the latter is 2 ft. above its seat. Automatic locks hold the bridge down when once seated. Each lock consists of two cams locked together by two segmental gears, and counterweighted to swing toward each other and grip a link hanging from the floor beam of the lift span. The cams are supported by a steel-casting anchor bolted to the piers, and the link, in descending, separates them and is in turn held by them when the end of the span is 1 in. above its final down position. Unlocking is accomplished by a foot-shaped bar, sliding vertically on the floor beam and connected by a wire rope to the lock lever in the operating house.

The counterweights of the Halsted St. bridge were made of cast iron, but considerable money has been saved on the Keithsburg bridge and on all later bridges by making them of concrete. Each weight is placed between two vertical steel members connected at the bottom by one or more laced struts and ending at the top in the equalizing devices to which the suspending ropes are attached.

A patented form of equalizer which makes the 16 ropes receive their load from a single pin effects a very material saving in space over the types using straight horizontal bars and vertical links, and has the advantage of being less seriously affected in the event of failure of one of the ropes.

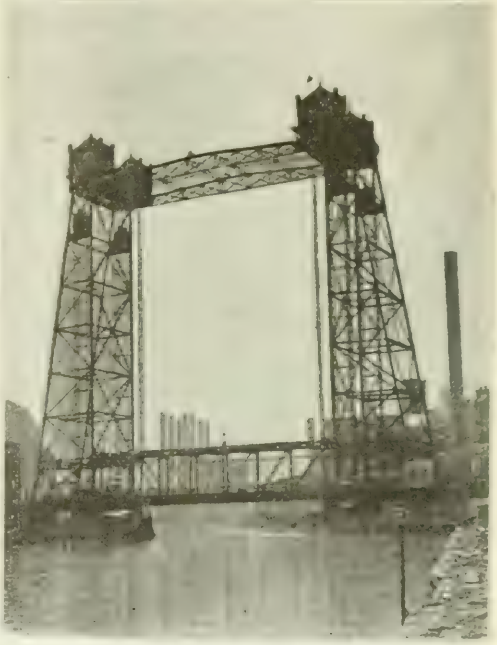

Fig. 1—Halsted Street Bridge Over South Branch of Chicago River, Chicago.

The third important bridge to be built was across the Willamette River at Hawthorne Ave., Portland, Ore. The lift span is 244 ft. long, and lifts 116 ft. In this design the machinery, located on the center of the span, is much more compact than in the Keithsburg bridge, all gears being mounted in the same frame instead of being supported on isolated bearings bolted to different parts of the steelwork. Operation is by two electric motors.

Electric power is far superior to any other for lift bridge operation, as it makes possible niceties in control. Direct current motors are the most economical to use because of their high starting torque in proportion to their size.

While the Hawthorne Ave. bridge was under construction another lift bridge of entirely different character was being designed. This was the 425-ft. span of the combined highway and railway bridge across the Missouri River at Kansas City. It consists of two decks, a fixed upper deck for highway and electric railway, and a lower deck for railway traffic, the hanger posts of the latter telescoping into the truss posts of the former as the lifting deck rises.

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*From the November Journal of the American Society of Mechanical Engineers; abstract of a paper prepared for the New York meeting of the society.

The live load coming on each lifting-deck hanger is carried by a pin into two saddle diaphrams in the upper deck truss. The dead load is carried into a pair of suspending ropes, which terminate in a counterweight after passing through the upper deck posts, over a deflector on the top chord, along the chord to the operating sheaves, and downward over another deflector. There are 15 panel points, for each truss, and each point, except the two in the center, has one counterweight; the center points have two each, making 32 in all. There are two operating sheaves at each end of the bridge, and each pair is controlled by a motor and gear train near it. All suspending ropes pass over the four operating sheaves. The two sets of machinery, one at each end, are made to act together by means of two rope drives, one acting when the span is lifting, the other when it is lowered.

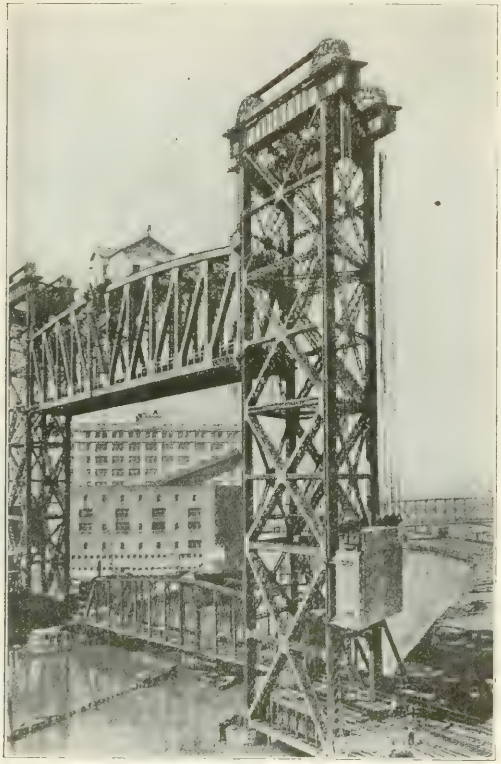

Fig. 2—Bridge No. 458, Pennsylvania Lines, After Removal of Falsework.

The old swing span was kept in service until the upper structure was completed.

Each intermediate panel point of the lower deck is locked by a cam, and each end of the span is latched by a lock operated by a wire rope pulled by a segmental sheave in one of the machinery houses. All the hanger locks, 26 in number, and the two end locks, are operated by the same motor and gear train.

The Willamette River bridge of the Oregon-Washington Railroad & Navigation Co. is a combination of a simple lift span and the lifting deck just described. This lift span is 211 ft. long, weighs 3,420,000 lb. and lifts 89 ft., while the lifting deck below it can lift independently for 46 ft., and will then lift with the span for 89 ft. The advantage of this arrangement is that the highway traffic on the upper deck is not interrupted for ordinary river traffic, as the upper deck must lift for high-masted vessels only. There are 5 or 6 full operations daily and 10 times that number of lower-deck lifts.

The large tower sheaves of this bridge are of 14 ft. pitch diameter, carry 16 2¼-in. ropes, and are made of cast-steel rim segments bolted to a center of rolled-steel plates and cast-steel hub. The sheave bearings are provided with a system of wedges which permits the replacement of the phosphor-bronze bushings.

The reason for making these large sheaves of built-up plates and castings was because of the difficulty of getting single steel castings of adequate size. However, considerable progress was made in three years in the manufacture of large steel castings. Two sheaves used in the Missouri River bridge at Mondak, Mont., are of 12-ft. pitch diameter, weigh 7½ tons each, and were built without any failures in casting.

In the bridge designed for the Vladicaucase Ry. for a crossing of the Don River near Rostoff, Russia, the drums are close together instead of being at the opposite ends of the main drive as is the case with the Pennsylvania R. R. bridge. The advantage in this arrangement is one of economy. A large gear reduction is made at the drums and there is only one line of shafting across the bridge. With the reduction used, the shaft is considerably smaller than one of the two required in former layouts. The gear frame is also much smaller.

One of the heaviest bridges so far designed is that over the south branch of the Chicago River, near 19th St., known as bridge No. 458 of the Pennsylvania Lines. This bridge carries the double track of the Pennsylvania Lines and will be used by the Pennsylvania, the Chicago & Alton, and the Pere Marquette. There is no closed season on the river at this point and the Government required that the lift span should be erected 120 ft. above the river, the normal clearance for the span when lifted. As it was not possible to drive any piling into the river bed because of the resulting obstruction to river traffic, the falsework had to be carried entirely on the piers and spread out from each of the latter in a fan shape upward to the panel points of the trusses. There were no connecting struts between the two sets of falsework and the upper end of the leaning members of each set had therefore to be tied back to the towers with steel bars and plates.

To erect the span with 120-ft. vertical clearance would have meant that these top chords of the falsework must in each case be attached to the tower legs half-way between two of the horizontal struts of the bracing, and as this was not considered advisable because of the resulting bending in the tower legs, it was necessary to erect the span high enough to allow these chords to come in line with the next higher struts. This placed it at 130 ft. clearance instead of the 120 ft. required. All connections were made in holes from which the rivets had for the time being been omitted.

On account of the shape of the falsework the erection of this span upon it would have developed an uplift in the shoes of the far tower legs too great to be safely carried by the anchor bolts, and it was therefore decided to build the concrete counterweights in such a way that their weight would be carried into these shoes. This was done by supporting the 800 tons of concrete at each tower on girders which delivered the load to two inclined struts bearing on 6-in. pins carried in saddle castings riveted into the columns just above the bases.

There was nothing unusual in the erection of the towers, the derricks being stepped up from story to story according to practice common for similar structures. The heaviest pieces in them are the bottom sections of vertical legs next to the lift span which weigh 42 tons each. The four sheaves on the top of each tower weigh 31 tons each and are the largest of their kind so far built. They are of 15 ft. pitch diameter and each pair carries 16 2¼-in. plow-steel ropes, each weighing with its sockets about 2,000 lb.

The span erection was carried on with two A-frame derricks, the work progressing on the two sides simultaneously. Only enough falsework to carry the end panel of the span was first set from the towers, and after the erection of these panels the derricks were moved from the towers to their first positions on the span, directly above the two sway frames nearest the ends. From here more falsework and more steel was erected and the derricks were again moved out. To regulate the temporary camber to suit the erection of the last pieces of top chord, four hydraulic jacks were set beneath the bottom chord, immediately above the ends of the four last members of the falsework. Because of the eccentric loading on the towers there was bound to be some deflection of each tower toward the river, but calculations and measurements had been so carefully made that the two center pieces of bottom chord, 73 ft. 6 in. in length and weighing 36 tons each, when lowered into place fitted so exactly that the erection bolts could be entered without the use of drift pins. To get the last pieces of top chord in it was necessary to use the jacks.

Fig. 2 shows the bridge after the removal of the falsework and while the old swing span was still in service. This latter was partly under the new bridge, both open and closed, and as more than 300 trains use this crossing every day it was very important to take great care that nothing should be dropped from the span 100 ft. above.

The new span is 272 ft. 9½ in. long, lifts 112 ft., and weighs 1,600 tons. At present it will be lifted at the rate of 15,000 times a year, for it lies near enough to the water to be in the way of every tug, but the great majority of these operations will require lifts of only a few feet. In a few years it is planned to raise the grade at this crossing, and the design of the bridge was carried out with this idea in view. Aside from raising the floor systems in the towers, lowering one story of tower bracings, and raising the base castings of the lift-span shoes, no change in this bridge will be necessary to accomplish this end. The span is operated by two 300-HP. series motors drawing their power from a 120-cell storage battery.

The electrical indicator and limit switch, connected to the drive by worm-gear reduction, indicates by lights in the operator's house several points in the height traveled by the span, and cuts the controller circuit near each limit of travel, thereby breaking the main circuit, stopping the motors, and applying the solenoid brakes. Waddell & Harrington were the designers, represented in the field by the writer, and the Pennsylvania Steel Co. were the contractors for fabrication and erection of superstructure.

## American Shipbuilding During the War

Between April 6, 1917, the date of the declaration of war by the United States, and Nov. 11, 1918, the date of the armistice, merchant vessels built in the United States and officially numbered by the Bureau of Navigation, Commerce Department, including also those built for our Allies or for neutral nations, numbered 2,985 of 3,091,695 gross tons, of which 506 of 2,056,814 gross tons were ocean steel steamers. Table I shows the output month by month.

## Conclusions on Causes of Concrete Disintegration*

By A. BLACKIE

The disintegration of concrete is due to the presence of the so-called alkali salts in the soil and to the presence of ground water which dissolves these salts and carries them into the concrete. The so-called alkali salts, that occur in the soil in this district are sulphate of sodium, magnesium and calcium; these salts are also found in the ground waters. The salts are found in deposits and I think are generally found only near the surface.

Chemical analysis of disintegrated concrete show that the disintegrated portion contains a much higher percentage of sulphate than the original materials used in the concrete, and also that the disintegrated mass is impregnated with minute crystals of calcium sulphate; these crystals are found in great quantities in the disintegrated material, and gradually become fewer as the portion of the concrete unacted upon is approached.

The solubilities of the above sulphates in cold water are in the following proportions:

$MgSO_4$ [illegible] parts in 100 parts cold water
$Na_2SO_4$ [illegible] parts in 100 parts cold water
$CaSO_4$ [illegible] parts in 100 parts cold water

As might be expected from their solubilities the deposits usually contain more calcium sulphate than Mg or Na sulphates.

**Action of Alkali on Concrete.**—Research into the chemical action of alkali on cement has been carried out for some years by different experiment stations in the United States, and all are agreed that the sulphates are the principal cause of the trouble. Just how they react with the concrete is disputed.

Bulletin 81 of the Montana Experiment Station, published in February, 1911, advances the theory that disintegration is due to the formation of compounds which have a greater molecular volume than that of the compounds in cement which are acted upon by the solutions, these cause expansion and subsequent cracking.

Another theory put forward is the formation of tri-calcium sulpho-aluminate, this compound causing cracking and subsequent disintegration. Technologic Paper No. 95, issued by the Bureau of Standards, in 1917, proves that this compound cannot be formed, but the authors of this bulletin do not commit themselves to any definite theory and summarize their work as far as it has gone with the following conclusion:

> No definite conclusions [illegible] waters of the project. However, the complete failures found at the [illegible] quality and proper workmanship are of greatest importance.

[illegible]

TABLE I—MONTHLY OUTPUT OF SHIPS BUILT IN AMERICAN YARDS

| Month | Steel Number | Steel Gross | Wood Number | Wood Gross | Total Number | Total Gross | [illegible] Number | [illegible] Gross | [illegible] Number | [illegible] Gross |
|---|---|---|---|---|---|---|---|---|---|---|
| 1917 | | | | | | | | | | |
| April 6 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| May | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| June | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| July | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 89,152 |
| August | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 117 | [illegible] |
| September | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 101 | [illegible] |
| October | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| November | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 117 | [illegible] |
| December | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1918 | | | | | | | | | | |
| January | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 84,795 |
| February | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| March | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 138 | 147,145 |
| April | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| May | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| June | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 201,125 |
| July | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 229,931 |
| August | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 295,849 |
| September | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 308,170 |
| October | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 357,722 |
| To Nov. 11 [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 63 | 165,014 |
| Grand total | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 3,091,695 |

[illegible]

made of selected and tested materials, so proportioned as to produce a dense concrete. As small an amount of mixing water should be used as will allow the mass to be properly placed. Unless these precautions are taken the resistance of the concrete to alkali will be reduced.

**Cement Draintile in Alkali Soil.**—On page 93 of Technologic Paper No. 95, Bureau of Standards, the following conclusions are drawn regarding the use of cement draintile exposed to soils and water containing alkali salts in quantities of 0.1 per cent or more:

1. The use of cement tile in soils containing alkali salts in large quantities is experimental.
2. Porous tile, due to the use of lean mixtures or relatively dry consistence, are subject to disintegration.
3. Some dense tile are, under certain conditions, subject to surface disintegration.
4. Disintegration is manifest by partial disruption, caused by the expansion resulting from the crystallization of salts in the pores and by softening, resulting from chemical action of the solutions with the constituents of cement.
5. While results obtained will not permit of a definite statement as to the relative effect of the various constituents of the salts, indications are that the greater the quantity of sulphate and magnesium present and the greater the total concentration of salts the greater will be the disintegrating effect.
6. Tile made by the process commonly used, which allows the removal of forms immediately after casting, are subject to disintegration where exposed to soils or waters containing one-tenth per cent or more alkali salts similar in composition to those encountered in this investigation.
7. The hand-tamped tile of plastic consistency, as made in this investigation, are not equal in quality to machine-made tile of the same mixture, and they do not resist alkali action as well.
8. Steam-cured tile show no greater resistance to alkali action than tile which are cured by systematic sprinkling with water.
9. Tile made of sand cement have less resistance to alkali action than tile made of Portland cement of the same proportions.
10. The tar coating, as used, is not effective in preventing the absorption of alkali salts from the soil.
11. The cement-grout coating is not effective in preventing the absorption of alkali salts from the soil.
12. No advantage is found in introducing ferrous sulfate into the cement mixture.

If cement draintile are to be used in alkali soils or waters containing 0.1 per cent or more of salts, similar in composition to those encountered in this investigation, they should be made of good quality aggregate in proportions of not less than 1 part Portland cement to 3 parts aggregate. The consistency should preferably be quaking, which has proved the most resistent of all mixtures used. This is wetter than that generally used in commercial tile plants and will probably require the retention of the tile in the molds for several hours, unless some means are found to hasten the hardening of the cement.

**Tests at University of Wyoming.**—The University of Wyoming Agricultural Experiment Station, Bulletin No. 113, published in March, 1917, summarizes the results of their work with the following conclusions:

1. Cement put into solutions of alkali sets as well as in water.
2. In solutions of sodium sulphate $CaSO_4$ $2H_2O$ is formed.
3. In solution of magnesium sulphate $CaSO_4$ $2H_2O$ and $Mg(OH)_2$ are formed.
4. In solution of sodium chloride a silicate is formed. The high percentage of sodium in this silicate is likely the reason for the increase of insoluble sodium in the cement.
5. Sodium chloride in solution or its presence in solution with other alkali salts, has its effect chiefly through a solvent action.
6. Of the solutions tested the 5 per cent sodium sulphate had the greatest disintegrating effect.
7. Solutions containing (mixed) chlorides, sulphates and carbonates had the least effect.
8. Mortars disintegrate faster than neat cement.
9. The formation of compounds of greater molecular volume than the volume of calcium hydroxide is not the cause of the disintegration of cement.
10. The ultimate cause of the disintegration of cement is due to the alkalis forming compounds with the elements of cement, which are subsequently removed from the cement by solution.

**Experiences at Winnipeg with Disintegrated Concrete.**—The conclusions drawn in all these summaries are more or less supported by experimental work and yet they are to some extent contradictory. This shows the necessity of further work and research on the question. However, the final paragraph of Bulletin 113 from the University of Wyoming, summarizes the whole situation, that is, that ground water must be taken care of. The writer's first experience of the disintegration of concrete occurred when some years ago in Winnipeg it was reported that one of the large concrete sewers of the city was being destroyed by sewage. The disintegration occurred high up in the sewer, and that there was no evidence of disintegration at or near the water level. The disintegrated concrete was soft and of putty-like consistency.

An analysis of a sample of disintegrated concrete from this sewer showed the sulphate content to be 2.54 per cent. The concrete from which the sewer was made consisted of limestone, sand and cement. Although we have no analysis of these materials it may be assumed that with the exception of the cement the concrete materials would not contain any sulphate. If we assume that the cement used contained 2 per cent $SO_3$, (the standard specifications require that Portland cement shall not contain more than 1.75 per cent $SO_3$), and that the concrete was mixed in proportions 1 part cement to 7 parts of aggregate, then the $SO_3$ in the concrete would be 0.25 per cent, yet the analysis shows $SO_3$ content 2.54 per cent.

Samples of concrete from four other sewers where disintegrated concrete was found showed $SO_3$ content 5.02 per cent, 5.03 per cent, 2.35 per cent and 5.90 per cent. These percentages are all very much higher than could be reasonably expected and confirm the results of laboratory experiments which show that solutions containing magnesium and sodium sulphate react with the cement and also the limestone.

From various minor laboratory experiments carried out by the writer at different times a conclusion was reached that some interesting information might be obtained and some light thrown upon the disintegration of the concrete by determining the action of the various alkali solutions upon the sands used locally in the composition of concrete. Accordingly some tests were made using a sand known locally as Birds Hill sand, and having the following composition:

| | Per cent. |
|---|---|
| Silica ($SO_2$) | 47.54 |
| Iron and alumina ($Fe_2O_3$&$Al_2O_3$) | 28.32 |
| Loss on ignition | 19.32 |
| Calcium (Ca) | 3.71 |
| Magnesium (Mg) | 0.57 |
| | 99.46 |

It was found that .009 per cent was soluble in water and of this .0012 per cent existed as water soluble sulphates, stated as $SO_3$. The sand was then extracted with the following solutions:

1. 10% magnesium sulphate.
2. 5% calcium sulphate plus 10% sodium chloride.

These experiments showed that to some extent these alkaline solutions had a solvent effect upon the lime in the sand. These tests were not brought to a definite conclusion and further investigation is necessary along this line.

Some further tests were then made on briquettes made with cement and limestone in proportions of 1 to 3 by weight. The limestone was graded so that its grains would be the same size as those of standard Ottawa sand. The briquettes were placed in the following solutions:

5% magnesium sulphate,
10% sodium sulphate,
5% calcium sulphate plus 5% sodium chloride.

And also in a solution made from white soil deposit having the composition:

| | |
|---|---|
| Calcium sulphate | 62.5 |
| Magnesium sulphate | 37.5 |

These briquettes showed rapid deterioration by softening of the edges, reduction in tensile strength, and also by the solution becoming turbid.

**Tests of Greater Winnipeg Water District.**—In previous experiments some indication had been given that mortar coming into contact with the alkali ground water before it had thoroughly hardened would disintegrate rapidly. With this in mind a series of tests were made in connection with the officials of the Greater Winnipeg Water District.

Four sands were selected for these tests differing both in grading and chemical composition. A large number of briquettes were made from these sands for 1 to 2 and 1 to

3 mortars. A set of neat cement briquettes were also made for comparison.

For each mortar 40 briquettes were made and cured 24 hours in a moist closet, 20 of these were then placed in the following solutions:

(1) Distilled water; (2) tap water; (3) 10 per cent magnesium sulphate; (4) 10 per cent sodium sulphate.

The remaining 20 briquettes were steamed by being placed on a rack over water in a copper boiler such as is used for testing cement pats. The temperature was maintained as nearly as possible at 150° F. After 48 hrs. steaming the briquettes were placed in solutions corresponding to those used for the unsteamed sets. From the five briquettes in each of the sulphate solutions two were removed and kept in air for 24 hours and then replaced in solution 24 hours. This treatment was continued throughout the test which was for a period of 3½ months. Some of the briquettes disintegrated and some remained firm. In general 1 to 2 mortars withstood the action of the sulphates better than the 1 to 3 mortars and the unsteamed briquettes better than the steamed. Some of the latter were so badly swollen and disintegrated that it was thought advisable not to break them but to keep them for exhibition. In order to throw some light on the cause of the failure of some of the mortars to resist the action of the sulphates some density tests were made on the various mortars used in these briquettes.

On comparing the figures obtained for density with the resistance of the mortars to the alkali solutions it was observed that in general for a given cement content the mortar with the lowest density disintegrated first.

In the case of standard Ottawa sand 1 to 3 mortar there is insufficient cement paste present to fill the voids in the sand. These briquettes disintegrated very badly. The neat cement specimens were practically unacted upon. One of the mortars on removal from the sulphate solutions showed a strength after 3½ months of 600 lb. whereas the strength of same mortar in distilled water for same time was 360 lb.

To summarize the results of these experiments. As far as they have gone they seem to indicate that the action of the sulphates on mortar is proportional to the porosity of the mortar. In view of the fact that comparatively little time has been available to go into this matter thoroughly the results of these tests should only be taken as pointing to a line of further investigation which should yield most interesting results.

## Ten Rules for Foremen

The following rules are reprinted from a recently issued bulletin of the National Safety Council:

Be fair. Have no favorites and no scapegoats. A foreman has to act as judge many times every day; therefore, he must be just.

Make few promises and keep them. A foreman must be exact in this particular. Sometimes a foreman forgets that his job requires a high standard of truth and honor.

Don't waste anger—use it. Anger is valuable and should not be used carelessly. Keep your most forceful language for special occasions.

Always hear the other side. Never blame a worker until he has been given a chance to give his point of view.

Don't hold spite—forgive. When you have had to scold a worker, go to him later and show him his faults in a friendly way.

Never show discouragement. Never let yourself be beaten. A foreman must have perseverance and the "never say die" spirit.

Notice good work as well as bad. Let the workers see that you can appreciate as well as condemn.

Watch for special ability. Take a keen human interest in your workers. Put each one where he can do his best.

Take your full share of blame. This is the most difficult of all. The foreman who can share both blame and praise with his workers has discovered the secret of managing men.

Prevent accidents. Educate or eliminate the careless man. The good foreman is known by his men.

## Qualifications and Opportunities for Engineer Salesmen in Export Field*

By S. T. HENRY.

[illegible]

Large and permanent export markets for standard American engineering machinery can be built up abroad by the introduction of American methods of using such machinery. The introduction abroad of American industrial methods was a slow and tedious process, until recently. Several large American manufacturers had, however, conducted such introductory work with marked success. They had sent into various countries of the world sales engineers, who were well grounded in the use of their machinery. While these engineers went as salesmen, their work was to educate the engineers and the industrial men of other countries regarding American methods. They had to show these prospective customers why our way was the cheaper way. They had to prove that the use of our standard machines would produce results more quickly and economically than special machinery. These men worked under great handicaps. But they made good. They demonstrated that it was then highly practicable to sell standard American machinery, instead of merely taking orders that were offered for special machines.

In the last two or three years conditions have changed completely. The world has learned more in that time about American engineering machinery and American engineering methods than could have been forced upon it in a generation through the most strenuous commercial efforts. Engineers from everywhere know the wonderful results our forces have achieved in building, equipping and operating port works, railways, highways, and machine shops in France. The world is ready now to adopt American industrial methods.

That this change has occurred is demonstrated by the character of the inquiries that are being received by every American manufacturer of engineering machinery who has made any real effort to secure export business. The great bulk of engineers from overseas do not inquire now about the technical details of the machines only. They want to know how the machines are used. They want to know whether the problems that they have to meet can be solved by American methods. The whole industrial world wants to be educated in our way of doing engineering work.

If the opportunity is handled right, no limitations of the trade possibilities thus presented need be considered. The thing is to put the work in the hands of men who are thoroughly schooled in American methods of using American machinery. It goes without saying that these men must have commercial sense. They must know how to deal with other business men. But above all they must have the "know how" of what they are trying to introduce. They must be able to sell ideas, not merely to take machinery orders.

A few examples may illustrate how engineer salesmen of such qualifications work. These examples also will indicate the type of men required to introduce American engineering methods and to sell the standard American machinery used in following such methods.

Take the largest American manufacturer of mining machinery: This concern and its predecessors consistently have followed for a generation a policy of using engineer salesmen abroad. The company has branch offices or agencies in all of the countries in the world where mining and quarrying are done on any considerable scale. In each of these branches or agencies there is located one or more engineers who have had considerable experience in American methods of mining and quarrying.

These men are actually selling drill holes in the rock and tons of ore in the car, instead of rock drills and compressors. When a new proposition comes up they help to study the conditions to be met and advise what equipment is best suited to these conditions. In the case of existing

*From a paper presented Nov. 13 before the Technical Publicity Association.

works they must go right in and prove how American machinery and American methods will save money as compared with what is being used. When up against cheap peon labor in Mexico, for example, it is not easy to get a native mine owner to substitute an expensive mechanical plant for plentiful hand labor. He must be shown that the cost per ton of ore brought to the surface is less with such a plant.

Work of this kind is too deep water for a commercial salesman who can readily switch from shoes to millinery. It requires men who know from experience what the customer wants to know. Men of these qualifications become practically a part of their customer's organizations.

Here is another case: American saw-mill machinery is used quite extensively in a far eastern country, as a result of the work of a single American engineer salesman. This man knew thoroughly American methods of cutting timber, handling logs and running saw-mills. When he went to this country a few years ago he was totally unfamiliar with the language. He went out and lived among the timber operators where he learned their language, their customs and their conditions. He did not meet the peculiar demands of the local lumbermen for machinery. Instead, he showed them how American methods could cut more and better lumber for them at less cost. These American methods required standard American machinery.

Scarcely a logging or a saw-mill job comes up in that country now without this man being consulted in regard to it. His knowledge of the engineering side of the business, his keen commercial sense, and his willingness to get right out on the firing line far outweighed his previous lack of knowledge of the language and customs. No commercial salesmen, familiar with the language and the customs of the country, but lacking the engineering knowledge of the trade, could have hoped to make good at all in this work.

Numerous other examples of the success of American engineer salesmen abroad could be cited. One more in an entirely different field should be sufficient to indicate the possibilities. In this case hand labor is employed in excavating and loading into small cars great quantities of a certain kind of commercial salt. The material lies almost at the surface in a stratum that is comparatively uniform in thickness and character over large areas of level ground. The industry is almost exclusively in the hands of English, German and native concerns. Their engineers were convinced that it was impracticable to use anything except hand labor in extracting the material from the ground and loading it into cars. The climatic and other conditions were such, at the same time, that it is very difficult to keep labor on the job.

Working under these great handicaps the industry has become one of the principal lines of business of an important country. Each of the workings involves a large investment for an extensive refinery and for railways leading from the point where the material is excavated to this refinery. The limitation on production is the amount of material that can be delivered to the plant. The cost of blasting and excavating the material also is a large part of the total cost of delivering the refined salt to the dock for shipment.

Based upon the opportunities thus presented an American concern sent an engineer salesman to study the situation. As a result of the work that has been done by this man in introducing American methods of excavating and handling the material, the indications are that the whole industry will be completely changed, so far as the field operations are concerned. The market thus presented for standard American equipment is a tremendous one.

Wherever you find an American sales engineer, trained for work in foreign fields, you will find him introducing American methods in the manner that these examples illustrate. At home you will find that the executives who have had experience with men of this calibre are convinced what overseas policy they must follow to get results. The ordinary commercial salesman simply will not do. The engineer salesman, of proper qualifications, is almost assured of success in realizing on the opportunities that are presented in foreign markets to American engineering machinery manufacturers.

Scarcity of the right kind of men is the one big problem in adopting a sales engineering policy in export marketing. So many qualifications are desirable that an enumeration of them would appear to reduce the candidates to a very few. Just as it is in domestic work, however, it rarely is possible to find a man who matches up completely to the requirements of the job.

It is comparatively easy to find men who are thoroughly grounded in American methods of using any line of engineering machinery. When these men are sorted on the basis of ability to deal with business men, the percentage of rejections is large. Those who do pass this test are nearly all eliminated when considered as to their commercial sense. This does not necessarily apply to their commercial experience, but rather to their ability to sense a commercial situation.

The few candidates who are left when these few, simple tests have been applied would nearly all be discarded on account of a lack of knowledge of any foreign languages. It frequently is necessary, therefore, to overlook this very essential qualification and to send out to a foreign country a man who must learn the language after he arrives. Any man who goes out thus handicapped is bound to have to work under very great difficulty. Experience gained by a number of American engineering machinery manufacturers has demonstrated, however, that such a handicap is far less serious than a lack of knowledge of American methods of using the machinery to be marketed.

This conclusion is heresy in the minds of most people experienced in regular commercial export trade. Right here it is well to draw a very definite line between the marketing abroad of commodities and articles of ordinary commerce and the sale of engineering machinery. In the one case it is unquestionably necessary to adapt the commodity or article to the needs of the country. For example, it is impracticable to attempt to substitute an American hatchet for a Cuban machete. It is likewise necessary for a salesman of shoes to know the whims of the average man and woman of the country in which he is trying to do business. But, antiquated industrial and engineering methods are much the same the world over. When the operations affected are sufficiently large to justify the use of machinery, instead of hand labor, the work is nearly always in charge of men who can understand engineering arguments. These arguments are the same everywhere. It certainly is a handicap not to be able to present them in the language of the men to whom an engineer salesman must talk. It is a far greater handicap, however, not to know what the arguments are.

The lack of business qualifications in most American engineers is a sad reflection on the work of our engineering schools. It is a fact, however, that the courses in these schools tend to give most of the young men who take them an entirely wrong viewpoint of the commercial side of engineering. Our technical societies also have over-stressed the ethical side to such an extent that an engineer who has anything to do with business loses more or less of his professional standing. This seems strange in light of the fact that engineering is, after all, a matter of dollars and cents. Such an attitude on the part of engineers toward business is probably a relic of the old days of pure science education. Whatever the cause may be, the time has arrived when our engineering schools and our engineering societies will either have to get a new viewpoint regarding commercial affairs or fail to produce the engineer salesmen which American industry needs so greatly.

Many suggestions have been made as to what courses our technical schools should give. One suggestion in regard to the foreign language work required of engineer students may not be amiss here. It would seem that these courses could be given in a practical way. Young engineers should study a language as it is studied by men who must have it for commercial use abroad. Most important of all, the student should be thoroughly convinced in advance of the value of the language to him. With some practical plan in place of the kind of language study now given, one of the chief handicaps to American engineer salesmen abroad would soon be eliminated.

# Construction of Concrete Grain Bins With Steel Forms Supported on Central Mast

A 5-bin 22,500 bu. capacity concrete grain storage tank was built in 6 weeks time with a gang of 5 men, by the Polk Genung Polk Co. of Fort Branch, Ind., for the Hanley Milling Co. of Coshocton, O. The battery consists of four 12-ft. circular bins 51 ft. high spaced 33 in. apart with straight connecting walls, forming a central interstice bin of about the same capacity as the circular tanks. The foundation is a 12-in. reinforced concrete slab, 30 ft. square with a 12 in. by 12 in. footing around the outer edge. This foundation slab forms the roof of the 6 ft. by 6 ft. conveyor tunnel, extending under the bins and paralleling the flour mill.

The circular walls of the bins are 6 in. thick, and the straight connecting walls are 8 in. thick. The reinforcing in the bin walls is ½ in. square twisted steel rods on 8 in. centers in the first 30 ft., and ⅜ in. rods on 8 in. centers for the remaining 21 ft. The straight walls carry the same reinforcing longitudinally, the bars extending into V-shaped grooves cast in the circular walls at the point of contact. Vertically the reinforcing consists of ⅜-in. bars on 29½-in. centers. The bins have a unit construction concrete roof, 8 in. thick at the center and 4 in. at the edge. The roof reinforcing is ¼-in. steel bars, on 6-in. centers. Surmounting the roof is a 12-ft. circular concrete monitor, containing the elevator and turn heads; all spouting is done directly into the tops of tanks and within the monitor.

The concrete walls for two circular bins were constructed simultaneously. Steel forms of the standard type employed by the contractors for construction of cylindrical structures were employed. These forms are 4 ft. high, and are made with steel plates having exterior horizontal angle stiffeners and vertical angle flanges at the joints between sections which are disconnected to permit stripping and moving the forms. The forms and scaffolds are suspended from a mast, consisting of a heavy 4-in. pipe centered with the bin, and are moved upwardly as the work progresses by means of steel jacks with a 1-ft. stroke, carried on an iron collar attached to the mast. A radial derrick arm with trolley hoist for elevating and delivering concrete to the forms also is attached to the mast. The arrangement is shown in Fig. 1. Figure 2 shows work underway on the second pair of bins after completion of the first pair. All the workmen on the job are shown in the illustration.

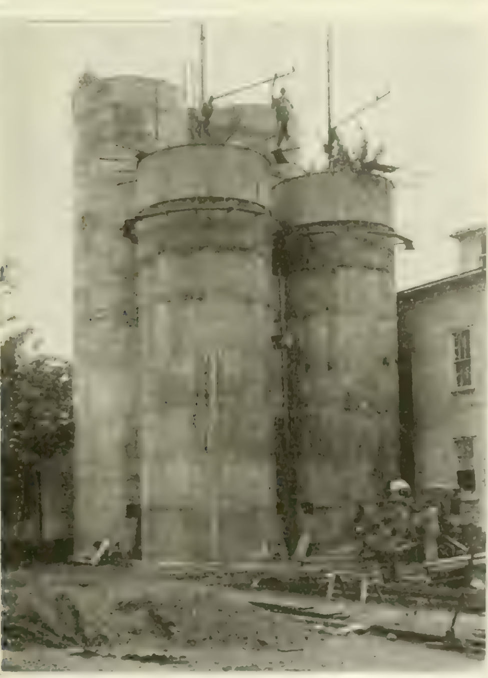
Fig 1—Arrangement of Forms, Radial Arms, Scaffolds and Mast.

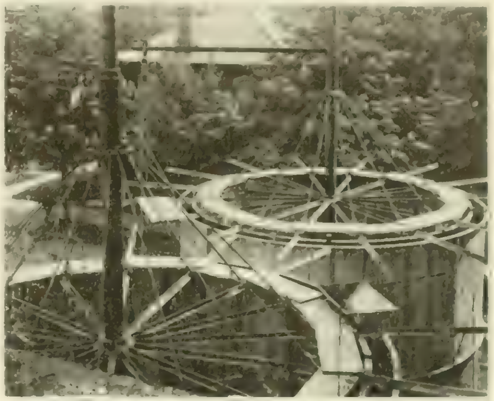
Fig. 2—Work Under Way on the Second Pair of Bins

## Quantity Surveys for Buildings

Competitive methods are more vicious today than ever. The age of efficiency which we are at present enveloped in is producing many fine, high class specialists, but in reality the whole scheme is nothing but a most scientific method of price reduction. For instance, if through your efficiency-man you can save a dollar a thousand in laying brick, what becomes of the dollar? The next job you figure you reduce that bid a dollar a thousand on brick and pass the result of your scientific organization work over your head back into the pockets of capital.

Out of all the chaos there finally comes a ray of light, more than a hope, a sure time proven process that will eliminate the evils of the present day competitive menace.

This acknowledged remedy is known as the "Central Quality Survey" method. Under its guiding hand a full value and uniform competitive list of quantities can be established in any market; it gathers statistical information of inestimable value, to in turn be imparted to all. It covers costs, estimating, standardization, credits, insurance, and such legal matters as must necessarily come under its scope; it has full association powers and has proven to be a direct producer of profits for those who have had the perseverance to incorporate the work.

This method touches the fundamentals of your business; it has as its first purpose the object of creating a full value list of quantities on each and every job. Skilled "Quantity Surveyors" draw the items off the plans, interview the architects, obtain all necessary details and information and are held responsible to interpret actually what is going to be used on each and every job.

We all know each item on a plan represents a certain value, and every item omitted is an absolute loss. The items on a plan represent the material you will be obligated to buy, and the labor you must pay for in executing the work. Therefore, the interpretation of every plan must be as near perfect as possible, free from confusion, and the only way to stop confusion is to have a job listed by one man carefully and properly and all competitors accept this uniform and correct interpretation. In fact, it is the most economic most efficient, most properly applied principle ever submitted to the building interests.—C. E. Flamboe in a **Builders' Bulletin** of the Master Builders' Association of Wisconsin.

## "It Was Our Trained Engineers Who Were Ready in the Hour of Need to Do the Deed"

By Wm. P. COMSTOCK in Architecture and Building.

With lofty thoughts and stilted ethics the architect has strode along without an appreciation of the progress about him, ever changing, searching, specializing. Business—life—is a continuous revolution. New precepts, rule to be superseded by even other newer precepts. The professional practice of architecture has not kept pace and is therefore doomed. It must be reborn from the ashes of the past, even as the legendary phoenix.

All have not been blind. Some—many, even—have seen the light and remodeled their course to meet the modern trend. These are the successful architects and busy builders of today who have met the demands of current development and from them won a deserved return. Chance or accident has not been an element in their progress which has been based on the sound business principle of true service rendered for value received.

The famed architects of antiquity were master builders. They designed freely and wrought wonderfully with the clay on their hands. They lived in the heydey of the artizan and craftsman; they were the leaders who rose above their fellows by the sheer might of their gifted prowess. Times have changed.

This is the age of standardization, machine made quantity production, rule by the multitude not by the few and yet our art lives on and reaches ever higher levels of attainment. Let our architects read the signs of the times and rise to new pinnacles based on our modern productiveness.

When our country went to war there was a sudden and enormous demand for construction on a vast scale; the Quartermaster's Corps of the Army had to provide housing for the new armies; extensive additions were necessary to existing manufacturing plants and even greater new factories were built over night as it were; office and executive buildings of great extent were demanded to house the ever extending executive departments of the Government; housing for operatives became a crying need in our great industrial centers; construction on a vast scale was necessary to meet the needs of our colossal new war machine, to build our ships and supply the materials of war.

To make possible this accomplishment, in all its ramifications vast to the extent of being almost incomprehensible, the organization of our Government departments was extended many fold; the personnel increased with a rapidity which was marvelous and an organization of professional talent created which today, after a year of war, is perfected and efficient in a remarkable degree. What is the status of this organization? How was it made up? And how was it possible for the Government in its hour of need to immediately get assistance?

It was the trained engineers of the country who became the technical advisers of the Government on planning, design and construction, utilization of existing facilities to the utmost, expansion of them and creation of new utilities. It was our trained engineers, already well organized in our great building construction firms into harmonious working units, companies, even regiments, who were ready in the hour of need to do the deed.

Professionally as such our architects have not been a factor in the greatest building emergency the country ever saw. Individually, to many the greatest praise is due. They have donned the uniform, striven at home and fought abroad and given of their best in ability, effort and resourcefulness. But as a profession in the oft vaunted position of autocrats of the building industry they have been wanting. And the reason is not beyond discernment; it is an inheritance from the past; architectural practice has not kept pace with the times.

The after-war period in the building industry will be a time of great enterprise and expansion. In this the architect should play a prominent part but his days of autocracy are over and his success will depend on his ability to cooperate, not dictate. Now when the architect secures a job he calls on the foundation builder to figure his footings, he depends on the steel contractor to design the structural members, he depends on the plumbing contractor to draw up his plumbing layout, he expects the electrical contractor—but why go on?—and when the building is finished he zealously, often belligerently, demands exclusive credit for its entire design and construction.

The day for this is past—and why? The architect has been losing business. Others who build better, more efficiently and more economically under the name of architectural or engineering contracting firms have taken the work from him and they work on the principle of cooperation, not autocracy.

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## Box Caissons with Concrete Bottoms Used in Construction of Mystic River Bridge Pier

The box caisson method was employed in the construction of two large channel piers in the Mystic River bridge of the Boston Elevated Ry. The largest pier was 124 ft. x 19 ft.; the other was 34.17 ft. by 19.16 ft.; both were carried down to about grade 69.5. The work was carried out by the Hugh Nawn Contracting Co. in the following manner:

The site of the pier was first dredged to a depth of about 3 ft. below the cut-off of the piles, which were then driven, and cut to grade by a circular saw mounted on the piledriver gins. Guide piles were then driven around the site of the pier, the caissons floated in place, gradually sinking to position as the concrete forms inside them were filled.

The bottoms of the caissons were really concrete scows, the bottom dimensions being of the exact sizes of the pier footings and were 4 ft. in height, being divided into compartments about 9 ft. wide by cross partitions. Around the bottom there projected a lip or flange having eye bolts cast into it, to which the wooden sides were attached by hook bolts extending for the full height of the sides, and were tightened by set nuts seating on the top sills.

The concrete caissons were built on ways, and launched at the north end of the bridge. The floor was of 3-in. spruce planks greased and laid on the ways in such a manner that by sawing through six planks the caisson was launched. The planks were thickly studded with 20d. nails to hold the concrete floor and sides which were cast directly in the forms.

The caissons were thoroughly reinforced, the sides and flange being 12 in., the bottom 6 in., and partitions 9 in. thick, made of 1:2:4 concrete.

Wooden sides were made in two sections, the bottom one being 16 ft. and the top one 17 ft. in height. The frame was of 10-in. by 10-in. and 10-in. by 12-in. hard pine, the bottom set was sheathed with 2-in. spruce planed, and the top set was sheathed with 2-in. spruce planed. The edges of the plank were beveled to provide for calking with oakum. These sides were used from three to four times each, and on account of their substantial and careful construction gave no trouble whatever; in most cases a single 3-in. duplex pump would handle all the leakage, in many instances under 14 ft. to 15 ft. head, by pumping a few moments at a time.

The advantages of this method were, economy of material, work all done in the dry, speed of operation and accuracy as to grade and alignment. The largest caisson sunk, which was 124.6 ft. long and 19.5 ft. wide, was successfully launched with lower sides in place, floated and sunk in place without trouble.

The general construction features of the Mystic River bridge were described by Mr. Clarence T. Fernald in a paper presented Sept. 18 before the Boston Society of Civil Engineers. The above note has been abstracted from Mr. Fernald's paper.

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**43% Capacity of Structural Shops Contracted For.**—The records of the Bridge Builders and Structural Society, as collected by its secretary, show that during the month of October 43 per cent of the entire capacity of the bridge and structural shops of the country was contracted for.

# Factory Stairs and Stairways*

By G. L. H. ARNOLD

In solving the stairway problem, consideration must be given to: (1) number; (2) location; (3) size; (4) type; (5) materials; (6) safety treads; (7) proportions; (8) landings; (9) handrails; (10) enclosures; (11) lighting; (12) wear.

**Number.**—Where building codes are in force, the minimum number of stairways permitted is usually ample. Perhaps the most usual code requirements are one stairway plus one for each 5,000 sq. ft. of lot area. In cases where the code provision is insufficient, and where there is no code, it is essential to consider: (a) safety; (b) capacity; (c) convenience.

Safety: No building over two stories in height is safe with less than two stairways. Large floors require an increased number of stairs even if but few people occupy the floor.

Two 4-ft. stairways for buildings having up to 20,000 sq. ft. of floor area, with one additional 4-ft. stair for each additional 10,000 sq. ft., is the least number that it is prudent to use.

If the building is liable to be used for purposes which may permit the occupants to be closely spaced, the number should be increased to two for the first 12,000 sq. ft. plus one for each additional 6,000 sq. ft.

At least one and preferably all of the stairways should be carried to the roof.

Capacity: In densely populated buildings the number of stairways must be increased to prevent dangerous overcrowding when all the occupants try to leave at once. In such cases, 20 in. in width for each 100 persons, the Boston rule for theater exits, is high, and 10 to 14 in. would be ample.

Convenience: No question of convenience should be permitted to cause stairs to be so located that any occupant of a factory would be obliged to travel over 100 ft. to reach an exit.

**Location.**—Every stairway should communicate directly with an exit from the building. The stairs should be distributed with a fair degree of uniformity and so placed as to reduce as much as possible the maximum distance to be traversed to reach an exit. On each floor the landing should be so placed that lines of men going from shop to locker room, locker room to stairs, and shop to stairs, should not conflict.

It is also highly desirable to avoid obstructing the foreman's view of the room. When practicable, the separate tower or wing is the most satisfactory location. The locker and toilet rooms and the elevator can be in the tower, thus leaving the main building clear of obstructions and giving the foreman an unobstructed view of the room and permitting greater freedom in the floor layout.

**Size.**—A clear width of 44 in. to 48 in. between handrails will allow the passage of two lines of people at once and the main stairs should never be less than this. If wider, the width should be in multiples of 22 in. to 24 in., the number of handrails being such that it is never less than 44 in. nor more than 48 in. between rails.

Where the number of employes is large, it is better to increase the number of 4-ft. stairs than to increase the width. Even when the number of employes in a building is large, only one floor, as a general thing, will be densely populated. This crowded floor is as likely to be at the top as at the bottom. Therefore, it is the usual practice to make factory stairways of constant width throughout their entire length.

Occasionally a factory building must be designed to accommodate dense population on two or more floors. In this case the employes from the upper floors coming down at the full capacity of the stairways will find the lower flights already taxed to the utmost and serious congestion will result. The remedy is increased widths for the lower flights.

Additional stairways from the lower crowded floors may not cure the trouble because, in the excitement of an emergency, when free and quick egress is most important, the occupants of the lower floors are likely to rush to the busiest stairway and leave their own special exit unused.

Special stairs, not used for general ingress and egress, may be as narrow as 20 in. in clear width; they may be steep, or, if not much used, they may have winders or be spiral.

**Type.**—Except for special cases used by but few people for intra-department shortcuts, spiral stairs and winders should never be permitted in a factory. Straight runs alone are permissible. When the story height exceeds 9 ft., the flights should be cut and intermediate landings used. The landings should be rectangular and the flights should be not less than three risers nor more than 9 ft. high.

The intermediate landing is of little use if the flights are in line. A turn at the landing serves to limit a fall. A 180° turn has the further advantage of reducing the floor space required. In fact, the stairway of minimum floor area (barring spirals) has a landing and a 180° turn every 4 ft. in its height.

**Materials.**—The factory stairs are usually of wood, cast iron, steel or steel with wood tread, steel with cast-iron tread, steel with stone tread, steel with concrete tread, or reinforced concrete.

The wooden stair in multi-story factories is not good practice. It is combustible and unsanitary. In buildings of mill construction, however, especially the smaller ones when not over four stories in height, sprinkled wood may be acceptable. The wood must be smooth, closely jointed, free from beads and not less than 2 in. thick, making a slow-burning construction. It is imperative that the wooden stairs be enclosed in a fireproof well.

The saving in cost, however, over a non-combustible stairway is not great enough to warrant the risk except in special cases. Cast iron and steel, while non-combustible, are not fireproof. Nevertheless, they are permissible when, as it always should be, the stairway is in a fireproof enclosure, since any fire hot enough to weaken the metals would render the stairway impassable.

Steel channels are more reliable for stringers and, except for short flights, cheaper than cast iron, and are more generally used. Risers are usually of angle and steel plate or pressed steel. Treads, while usually of cast iron, are frequently of checkered steel plate, wood, slate or concrete.

Cast iron and steel plate, wear slippery and hence they are dangerous and should never be used without some sort of safety tread.

Wood, because of its inflammability, should not be used except as a safety tread over a solid sub-tread. Slate does not wear slippery, but it is more expensive. It must be backed up by steel plate and replacements are expensive.

Concrete as a tread on steel stairs has no special advantage. The steel plate under tread is needed as it is for wood or slate, and to facilitate casting the steel is usually carried up to form a nosing. This is dangerous. The concrete is liable to crack off or wear below the top of the steel, leaving a lip over which, sooner or later, some one will trip and fall.

Reinforced concrete makes perhaps the most satisfactory stair if properly designed and built. There should be a good fillet between tread and riser for sanitary reasons, at least. There should be a nosing, which is not difficult to cast if made with a large fillet.

**Safety Treads.**—Steel, cast iron, and concrete wear slippery and so become dangerous. Consequently, some form of safety tread must be used. Safety treads are made of: (a) lead; (b) abrasive material; (c) a combination of the two; (d) cork; (e) wood.

Lead Safety Tread: The lead safety tread is made by inserting plugs of lead in pockets in a steel frame, the whole being fastened to the tread proper by screws. This of course wears more rapidly than cast iron or steel, but does not become slippery and has no affinity for ice or snow. It is easily replaced when worn. The chief objections to it are that, owing to the grooves between the lead plugs, it is difficult to keep clean, and there is a chance for a heel to catch in the grooves.

Abrasive Safety Tread: The abrasive tread is made of alundum or carborundum cast into hard metal, leaving the grit projecting slightly above the surface of the metal. The abrasive is also imbedded in the rounded nosing to prevent slipping on the edge of the step.

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*From the November Journal American Society of Mechanical Engineers. Abstract of a paper to be presented at the New York meeting of the Society.

This type of safety tread is made to be used as the complete tread as well as the renewable safety tread bolted to a sub-tread. It is also made as a nosing, this form being especially useful on concrete stairs.

This is probably the most durable tread in heavy traffic. It is, however, hard and noisy and, like the lead tread, it is difficult to keep entirely clean. There is also a chance that the grit may be too sharp: Instances are known where the shoe has been gripped so firmly as to cause a fall.

Combined Lead and Abrasive Safety Tread: A third type of safety tread is made of grains of abrasive in a lead matrix, the whole carried on a steel plate. It is made either grooved or flat, and with the anti-slip surface carried to the front edge.

The flat top is a great advantage as it makes it possible to keep the stairs clean. For outdoor use, it shares with the lead tread the advantage that snow or ice do not adhere. It also shares with the other type of abrasive tread the danger of too acute a grip.

With either of the above three types of tread, it is not necessary to cover the entire width of the tread. If the front edge of the step to a depth of 3 in. to 3½ in. is protected by a non-slipping surface, the remainder of the tread only needs to be brought up flush with the safety strip.

Cork Tread: Cork as a safety tread is not so well known nor so widely used as it deserves to be. It is impervious to almost all liquids and hence is easily kept in a really sanitary condition. It is noiseless, wears surprisingly well and is the pleasantest of all materials on which to walk.

Unfortunately, its lack of strength makes it necessary to use a metal or wood nosing. This is not dangerous, however, because owing to the elasticity of the cork, the nosing will wear ahead of it.

When stairs are liable to rough usage, as by dragging heavy pieces up or down, the cork tile is sometimes used with a nosing having a lead or abrasive non-slip surface.

For use as a safety tread, the cork is compressed into tiles ½ in. thick by 9 to 12 in. sq. These are cemented to the sub-tread.

Wood Safety Tread: Except under the heaviest traffic, wood makes a splendid safety tread. Laid directly on top of a solid steel or concrete base and exposed only on the top and front edge, the fire risk is practically eliminated.

Wood offers one of the most satisfactory surfaces to step on. It is never slippery and it is cheap. The worst objection to it is from a sanitary viewpoint because it absorbs expectoration.

The wood should be either oak, maple or edge-grain yellow pine to wear well, the last-named being undoubtedly the longest-lived. Each tread should be made in three pieces. The rear strip will never need to be renewed and the center strip but rarely.

**Proportions.**—Although the pitch of stairs must be kept within comparatively narrow limits for best results, still it is possible to make a safe and reasonably comfortable stair at almost any pitch if due regard is paid to relation of rise to length of run.

The natural length of steps decreases rapidly as the grade increases, even on a ramp where the surface offers equal foothold at all points.

Failure to take this fact into consideration results in a stair which is awkward and tiresome, with a pronounced tendency to produce stumbling and falls.

The length of the foot, or rather of the shoe, is not an important factor. For one thing, the actual length of the tread exceeds the run by the amount of the nosing. For another, practically all the work of ascending and descending stairs is done by the ball of the foot. In ascending the weight is borne on the ball of the foot in the middle of the step while the heel projects in the air. In descending, the toe projects, the weight being borne on the ball on, or just back from, the edge of the step, the heel barely touching the step.

For adults, making the length of the run plus twice the rise equal to 24 in. to 24½ in. can be relied upon to give satisfactory proportions.

By this rule, the rungs of a ladder should have a 12-in. spacing, which is the recognized standard, and a 45° stair would have an 8-in. rise and an 8-in. run, which a wide experience shows to be entirely satisfactory. A horizontal grating would have a 24-in. spacing, which, although a trifle short, is nevertheless within the bounds of practicability.

In factory practice, the tendency is to make the stairs steep in order to save room. Observation by several people over a period of years and under a wide variety of circumstances confirms the opinion that an 8-in. rise by an 8-in. run is the steepest stair practicable for general use and that 7½-in. rise by 9-in. run is much better. Some building codes prescribe 7½ in. as the maximum height or run. Although 7-in. rise by 10-in. run makes probably the easiest of all stairs the improvement over 7½ in. by 9 in. is not wholly worth the extra floor space consumed.

Out-of-doors stairs or steps should be made with only 6-in. rise, if possible. In any case, the rise and run must be uniform throughout the entire length of the stairway. Otherwise, falls will be frequent.

**Landings.**—All landings should be rectangular and at least as deep as the stairs are wide. The surface should be of the same material as the stair treads. Attempts to save room by cutting off corners or reducing the size of landings, or by the introduction of winders or straight steps invariably result in accidents, especially when the stairs are crowded and every one is in a hurry.

**Handrails.**—Each line of people on the stairway should have a continuous, firmly supported handrail at a convenient height and of such size and shape as to be readily and securely grasped.

The material may be of wood or metal. If of metal, the rail will usually be iron or occasionally brass pipe and of 1½ in. or 1¼-in. iron-pipe size. The 1¼-in., although somewhat small, has the advantage that the fittings are more generally carried in stock. Large sizes are used but they are objectionable as they cannot be grasped securely in the frantic effort to recover from a misstep, especially by a person with small hands.

T-bars and special rolled, drawn or cast handrail sections, are frequently used but, except for the architectural effect, they have no advantage over the cheap and homely wrought-iron pipe.

If the rail is of wood, it should be of oak, ash of some other non-splitting hardwood; never yellow pine. It may be a round bar not less than 1¾ in. in diameter nor more than 2¼ in., or it may be one of the stock patterns carried by the mills.

In any case it must be strongly supported at a height of 31 to 33 in. above the front edge of the step. Around the landing, the height should be 36 in.

Open stairs require either a second rail at half height or a strong wire netting between stair and rail.

**Enclosures.**—Notwithstanding the fire risk, the danger from things dropped or thrown, the chance for falls and the increased difficulty of heating, open stairways are frequently found in factories.

Every stairway should be enclosed in a fireproof well. In many cities a wire grill is permitted between stairs and elevators in the same well. A solid partition is more satisfactory and pays for the extra room and expense.

Choice of material will be governed by the same considerations as in the case of the other partitions.

The space under the bottom flight must be left open and kept clean unless filled up solid with non-combustible material.

If the stairs extend to the roof, the enclosure should be carried above the roof in the form of a bulkhead or penthouse high enough to allow a door 6 ft. 6 in. to 7 ft. in height.

If the roof flight is a ladder or a very steep stair, the pent-house may be replaced by a scuttle, or better, by a companion.

The door or scuttle should be hooked, latched or bolted in such a way that, at any time, it can be opened readily from the inside.

The roof of the stair well should be a skylight with a wire netting under the glass to catch pieces of glass in case of breakage.

At each story liberal wire-glass windows with metal frames should be provided so that the whole shaft shall be as light as may be in daylight. The better, the illumination is, the fewer days in a year will artificial light be required.

All stairway openings should be closed with Underwriter automatic fire doors opening with the outgoing current. The outside doors need not be fire doors but should open out. Where there is much traffic, the fire doors may be supplemented by glazed double-acting doors.

The locks on all these doors should be such that under no circumstances can a person be locked in.

Care should be exercised to locate these doors so that they may be opened without risk of crowding some one off the landing and so that a stream of people descending cannot prevent them from being opened.

**Lighting.**—In the artificial illumination of the shaft, brilliancy is not required but thorough distribution is. A light should be placed at each floor and each turn. The lighting should be in duplicate.

Since there is always a likelihood of a small group of employes being in the place at night after the stair lights are out, it is quite necessary to reduce to a minimum the distance one must grope in the dark. For this reason the electric lights should have double-acting switches at each end of each circuit and the emergency lights, whether gas, candle or lantern, should be so placed that each flight can be lighted on the spot.

**Wear.**—Mr. F. A. Waldron, during the years 1896 to 1906, at the Yale & Towne Manufacturing Co., made extensive experiments on the wear of wooden treads constructed in three pieces. Hard maple, on account of its superiority for flooring, was taken as a basis of comparison. Mr. Waldron's method was to use the hard maple on every other step, putting the wood on trial on the alternate steps. Ordinary yellow pine proved to be very short-lived. Edge-grain yellow pine, on the other hand, proved to be by far the most durable, outwearing the maple two to one.

Where safety treads 3 in. or 3½ in. wide are used, practically all the wear will come on the safety tread and only this will need renewal.

# Railway Practice in Design of Concrete Floor Slabs and Flat Top Culverts

Several years ago Mr. Geo. H. Tinker, Bridge Engineer, New York, Chicago & St. Louis R. R., sent a letter to bridge engineers of various railroads asking the following questions:

(1) In the designing of flat top culverts or reinforced concrete floor slabs, what is your practice in considering the distribution of axle loads—longitudinally, transversely and vertically?

(2) In connection with the above, what impact allowance do you use?

In the October Bulletin of the American Railway Engineering Association Mr. Tinker gives an abstract of the replies to the questionnaire, and a summary and short analysis of some of the salient points. Table I summarizes the replies:

Under the head of "Distribution of axle loads, longitudinally," it will be noticed that 12 engineers use "concentrated" loads and six "uniform" loads. These generally mean the same thing, i. e., a moment taken from the moment table for concentrated loads or an equivalent load deduced from it. Combining these, it appears that 56 per cent use the moment table, 28 per cent distribute an axle load over 5 ft., 16 per cent over 4 ft. and 3 per cent over 2 ft.

Referring to distribution transversely, it should be noted that all of those noted as 8 ft., 9 ft., 10 ft. or tie, indicate a uniform distribution for the length of the tie or slightly more, depending on whether the writer considers the distribution at the level of the base of rail or a few inches below the bottom of the tie. Those given as 12 ft., 13 ft., or 14 ft., are included with those specifying uniform distribution for the distance between tracks. From this is appears that 71 per cent distribute over the length of the ties, 23 per cent over the distance between tracks, and 6 per cent over a distance of 5 or 6 ft.

By "vertical" distribution is meant the lateral distribu-

TABLE I—SUMMARY OF REPLIES

| Distribution of Axle Loads | | | |
|---|---|---|---|
| Engr. No. Longitudinally | Transversely | Vertically | Impact. |
| | | | 10% [illegible] culverts. |
| 2 Uniform .... | 10 ft. | (Vertical) | [illegible] |
| [illegible] Concentrated | 10 ft. | (Vertical) | [illegible] |
| [illegible] | Tie | 12" per ft. | 75% for d<5 ft. |
| 5 Concentrated . | [illegible] of slab ... | [illegible] | [illegible] full impact for [illegible] |
| [illegible] 12,000 lbs. per sq. ft. [illegible] | [illegible] | [illegible] | 50%. |
| [illegible] | 10 ft. | [illegible] per ft. | [illegible] for d<15 ft. |
| [illegible] Concentrated | 10 ft. | Vertical | Full impact, S 300/[illegible] |
| [illegible] | [illegible] | (Vertical) | Full impact, L [illegible] L/[illegible] |
| 10 Uniform: 2,000 lbs. per sq. ft. for culverts | [illegible] | (Vertical) | No impact for culverts. |
| Concentrated for floor slabs | [illegible] | (Vertical) | 50% of S 300/[illegible] |
| 11 [illegible] | [illegible] | [illegible] | [illegible] L/[illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] L/(L + D) |
| [illegible] | [illegible] | (Vertical) | [illegible] L/(L + D) |
| 12 [illegible] | [illegible] | [illegible] per ft. | [illegible] |
| 13 [illegible] | [illegible] ft. to 16 ft for d 10 ft | 3" per ft. to 6" per ft. | [illegible] |
| [illegible] | [illegible] | [illegible] per ft..... | Lower unit stresses |
| [illegible] | [illegible] | [illegible] | Full impact S [illegible] |
| [illegible] | | Vertical | 100% [illegible] |
| [illegible] Concentrated . | [illegible] | (Vertical) | Full impact S [illegible]/300 + [illegible] |
| [illegible] Concentrated . | [illegible] | 24" per ft. | 100%. |
| [illegible] Uniform | [illegible] | (Vertical) | None. |
| [illegible] | [illegible] | Vertical .. | Full impact, S 300/[illegible] |
| [illegible] | Tie | [illegible] | Full impact, [illegible] |
| [illegible] Concentrated . | [illegible] | (Vertical) | ½ unit stress for L.L. |
| [illegible] Concentrated | [illegible] | (Vertical) | Full impact. |
| [illegible] | [illegible] | 12" per ft. | Full impact for [illegible] S [illegible] |
| [illegible] | [illegible] | 12" per ft. | 50% [illegible] |
| [illegible] | [illegible] | [illegible] | Full impact for d [illegible] S [illegible] for d=12'. |
| [illegible] Concentrated | | | D × L/[illegible] |
| [illegible] | Tie [illegible] | [illegible] per ft. 2x15" for culverts [illegible] | [illegible] 50%. |
| 30 Concentrated . | [illegible] | [illegible] | Full impact, S [illegible] |
| [illegible] | [illegible] | (Vertical) | [illegible] for d>5 ft |
| [illegible] Concentrated | 10 ft. | 12" per ft. | [illegible] |

[illegible] Min. [illegible] Max [illegible] tion at varying depths below the rail. Five each, or 15 per cent, specify vertical, 6 in. per foot and 12 in. per foot, and four, or 12 per cent, 24 in. per foot. Eleven others have been shown as (vertical), as best indicating the distribution as shown by the context. Combining these, it appears that 44 per cent prefer a vertical distribution as against 56 per cent who prefer a lateral distribution varying from 3 in. per foot to 24 in. per foot. It should be noted that 24 in. per foot is a slope of 45° at each end of the tie.

The impact requirements are various and intricate. Some of the salient points may be indicated as follows:

39 per cent use 50 per cent impact; 45 per cent use 50 per cent or less.

42 per cent use 100 per cent impact; 55 per cent use over 50 per cent.

60 per cent use constant impact for all depths of fill.

31 per cent use varying impact for different depths.

51 per cent use a simple percentage of impact.

45 per cent use a formula.

## Breaking Up Brick Masonry With Dynamite

By CHAS. E. RIKER.

A bank in this locality had a large vault. It was made of brick set in the best Portland cement and guaranteed to be fire and burglar proof. The walls were 20 in. thick and the vault was 14 ft. long, 12 ft. wide and 7½ ft. high. The roof was 2½ ft. thick, supported by six 12-in. I-beams, each weighing 325 pounds. The whole constituted a ton of steel and 49 tons of brick and cement.

When the bank took up new quarters across the street, it was necessary to dispose of the vault and I was employed to remove it. There were five plate glass windows 40 ft. away, besides seven transoms, four small windows and four glass doors which were in close range. The brick side walls were 4 ft. away and the ceiling 14 in. from the top of the vault.

I protected the plate glass by a canvas screen hung from the ceiling. The windows I boarded over. Five feet away from the vault on one side with only a thin brick wall intervening were girls selling dry goods and on the other side several girls trimming hats.

I first drilled a 12-in. hole into the wall of the vault near the door and loaded it with 1-3 cartridge of 40% dynamite, tamping the charge with damp sand. Before firing the charge, I placed some heavy planks and timber, also a heavy canvas, over the bore hole. The shot which of course was a light one, merely loosened a number of bricks, but it gave me an idea how heavily I could load.

I then loaded three holes 18 in. apart and 18 in. from the free end of the wall, which were fired simultaneously by means of a blasting machine. These holes were also loaded with light charges as, of course, it was necessary to break up the concrete in small bites rather than to attempt to smash it up with one charge as would have been easily possible had it been out in the open and there had been no necessity for protecting nearby buildings and glass.

The job was finished in fourteen days. The salvage was mine and reckoned as part of my compensation. I sold the I-beams for $31; some miscellaneous junk for $1.75; and the brick and other salvage material for sufficient to make my total receipts $235.75. I paid $28.83 for team hire, $44.25 for labor, $2.60 for dynamite, $5 for electric blasting caps and $5 for incidental expenses. My own time I figured at $5 per day.

## The Strength of Large Brick Piers

A final report on an investigation of the strength of large brick piers has been issued as Technologic Paper No. 111 by the U. S. Bureau of Standards. The investigation was conducted in the Pittsburgh Laboratory of the Bureau in co-operation with the National Brick Manufacturers' Association. Its purpose was to determine the strength developed by brick piers of normal size as used in modern buildings. Tests were made on 40 piers 30 in. x 30 in. x 10 ft. high, and four supplementary piers of the same cross sectional dimensions by 5 ft. high. The bricks used were representative of four districts east of the Mississippi River. The conclusions based on the results of the investigations and study of previous tests were as follows:

The primary failure of brick piers is caused by a transverse failure of the individual bricks.

The ultimate strength of the pier may be increased by any method of construction which will increase the depth of the component parts of the pier. This may be done by (1) laying the bricks on edge instead of flat, (2) breaking joints every few courses instead of every course, or (3) using bricks of more than ordinary thickness.

The strength of the pier may be increased by the introduction of wire mesh in all horizontal joints. The increase is slight, however, unless the mesh is used in every joint.

Varying the number of header courses used does not appreciably affect the ultimate strength of the pier.

The mortar joints should be made as thin as possible. They should be of uniform thickness. For this reason regularity in shape of the bricks is essential.

The ultimate strength of brick piers is proportional to the compressive and transverse strength of the bricks used in their construction.

The kind of mortar used is important in its effect on the strength of brick masonry. A pure lime mortar is inefficient when a high compressive strength is desired. In a mortar of 1 part Portland cement to 3 parts sand, 25 per cent by volume of the cement may be replaced by hydrated lime without appreciably affecting the strength of brick piers. Higher percentages of lime up to 50 per cent by volume may be used on piers of small cross sectional dimensions.

The following empirical formulas for use in computing the strength of brick piers are derived from the tests of the investigation:

(1) $P = K p$

(2) $P = K R$, where

$P$ = the ultimate unit compressive strength of the pier,

$p$ = the unit compressive strength of the single bricks,

$R$ = the unit transverse strength or modulus of rupture of the single bricks,

$K$ is a constant depending upon the grade of mortar used, and for which the following values are given:

| Mortar. | Values to be determined by tests of individual bricks. | Value of K. |
|---|---|---|
| 1 (15 per cent lime, 85 per cent cement) to 3 parts sand, by weight | Unit compressive strength flat = p | 0.26 |
| | Unit compressive strength on edge = p | .30 |
| | Modulus of rupture from transverse test = R | 1.25 |
| 1 part lime to 6 parts sand | Unit compressive strength flat = p | .11 |
| | Unit compressive strength on edge = p | .14 |
| | Modulus of rupture from transverse test = R | .65 |
| 1 part cement to 3 parts sand | Unit compressive strength flat = p | .27 |
| | Unit compressive strength on edge = p | .32 |
| | Modulus of rupture from transverse test = R | 1.45 |

**Italy Preparing for Reconstruction Period.**—Italy has started on a definite reconstruction program and nearly 3,500,000,000 lire ($665,000,000) have been appropriated to carry it out, according to an official dispatch of Nov. 20 from Rome. Measures have been adopted to permit all war factories to resume peace production immediately. One billion, eight hundred million lire have been designated for railway reconstruction; one billion for public works and drainage of harbors; five hundred million for other works of public utility, and one hundred million to cope with the situation created by the large number of unemployed.

# Standardization of Detail in Highway Bridge Design

It is not common for the plans of an important structure designed to meet certain conditions at one location to be used a second time with but little change. Nevertheless, there are occasions, as Mr. M. W. Torkelson, Bridge Engineer of the Wisconsin Highway Commission, points out in an article in the Concrete Highway Magazine, when by simple alterations old plans can be made to serve for a new bridge. In his article, which is reprinted below, Mr. Torkelson shows the advantages of standardizing details in highway bridge design, and discusses briefly this feature as employed in the work of the Wisconsin Highway Commission.

In addition to its standard designs, which number about 200 the Wisconsin Highway Commission has prepared approximately 2,600 special bridge designs which range from the simplest abutment plan to highly complex reinforced concrete arch and girder designs. All of these special designs are worked out in very complete detail and records are carefully kept indexed by type and dimensions, so that when need arises for any particular kind of bridge it is a simple matter to select a plan most nearly fitting the structure needed. Sometimes very simple alterations which can be shown on the blueprints will make the old plans serve. Generally new drawings must be made so that there will be no misunderstanding about what is included in any particular contract, but with the old plans to serve as a guide, the work is greatly facilitated. Often a new design is made by utilizing portions of several previous plans, which may vary widely but which nevertheless contain the elements used in the proposed new structure. The practice followed is illustrated by the following example:

Recently one of our counties decided to build a bridge consisting of a steel span of 80 ft. over the main stream channel with three 30-ft. reinforced concrete spans at one end and one 30-ft. reinforced concrete span at the other. Arrangements had been made for immediate construction. The builder was on the ground and plans were desired with the least possible delay.

The design was most unusual and an individual plan absolutely necessary, but as the builder was ready to proceed, a search was made through designs already on hand to see what could be adapted to the new work. An abutment plan was found which fitted exactly and a superstructure plan which showed every bar required in the superstructure detail, the only change necessary being that the bill of bars was doubled. The prints of these old drawings together with a hastily drawn layout sketch and some written instructions were forwarded to the builder in the same day's mail, thus enabling him to at once begin work on the abutments and to order steel reinforcement for the superstructure, which required accurate shop bending. The 80-ft. steel span had already been ordered, the Commission's standard design being used.

The situation required piers of simple yet special design. Plans were made within two days and placed in the builder's hands. He was then in possession of a complete bill of all material, including details of all bars and the working plan within three days after the time our office was advised the work was under way. Abutment and superstructure plans were then redrawn for the particular case at hand and the individual plans and specifications made up. The design of the superstructure and abutments was simple, the greater portion of the work being mere tracing.

During June and July, 1918, the Commission designed and furnished complete plans and specifications in sets of four for 152 bridges averaging about three complete designs per day. Each design is made to fit the particular site where it is to be built. Quantities are calculated and details of each bar shown on the plans so that the complete bill of bars can be purchased, bent in a shop to an accurate template.

The force by which this was accomplished under the writer's direction consists of an assistant, three draftsmen and a stenographer. While a number of [illegible] were standard designs requiring only slight adjustment, there was a considerable number of [illegible] special [illegible]. One in particular involved an [illegible] amount of new work and kept our best draftsmen completely occupied for three weeks.

It is the practice, when any new feature is introduced, to work out all details with utmost completeness. When this feature is used on another job, the new design is a very simple matter. This practice, together with the complete record of the details of work already turned out, makes possible our large output.

Great care must be taken, however, in determining the extent to which standardization shall be carried. Undeviating adherence to standard designs often produces poor results, considered both from the standpoint of design as affecting a particular location and from the standpoint of economy. Proper design requires consideration of the needs of each location and proper provision therefore, even in a country bridge. It has been suggested that a concrete pile trestle will serve for all locations, the only variations being in length and width of trestle and length of piles, but this is as absurd as it would be to expect one style of garment to fit all figures, the only alteration being in the amount of cloth. There must be individual design, and the methods briefly described above are effective in producing it at low cost.

# Plans Made for Building Operations to Cost $450,000,000

A recent survey of the building situation made by the F. W. Dodge Co., indicates that plans and specifications have been prepared for new construction that will cost at least $450,000,000. These figures are based on reports from about 400 widely distributed architects and engineers, and cover private, semi-public and municipal projects, the progress of which has been retarded by war time restrictions on non-essential construction. A partial list of the new operations follows:

| Location | No of [illegible] | [illegible] |
|---|---|---|
| New York | [illegible] | [illegible] |
| Brooklyn | [illegible] | [illegible] |
| Newark | [illegible] | [illegible] |
| Boston | 12 | 20,816,000 |
| Worcester, Mass. | [illegible] | [illegible] |
| East Massachusetts cities | 17 | [illegible] |
| Maine and New Hampshire | [illegible] | [illegible] |
| Connecticut | [illegible] | [illegible] |
| Philadelphia, Pa. | [illegible] | [illegible] |
| Trenton and Camden, N. J. | [illegible] | [illegible] |
| East Pennsylvania cities | [illegible] | [illegible] |
| Baltimore | [illegible] | [illegible] |
| Pittsburgh | [illegible] | [illegible] |
| Cleveland, O. | [illegible] | [illegible] |
| Columbus, O. | [illegible] | [illegible] |
| Cincinnati, O. | [illegible] | [illegible] |
| Chicago, Ill. | [illegible] | [illegible] |
| Total | [illegible] | [illegible] |

Of the total, $189,951,000 is for industrial and office buildings; $42,403,000 is for apartments, stores and restaurants; $104,614,000 is for institutions, churches, and municipal, and $38,171,000 for miscellaneous schools.

# One Engineering Society Acts to Secure "After the War Work"

The Engineers Society of St. Paul at one of its meetings in October considered the question of employment for the returning soldiers, particularly the engineering units. The following resolution was adopted by the Society:

Whereas, A large field for the employment of [illegible] and [illegible] will be provided by [illegible] the construction of extensive public improvements such as highways, paving, bridges, sewers and waterworks, and also of private projects, many of which have been suspended during the war, be it therefore

Resolved, That public officials and private interests who will have such construction [illegible] be urged to take immediate action toward completing the preliminary steps and formulating plans for such construction work.

## War Industry Board Removes All Restrictions on Building Construction

The War Industries Board has removed all restrictions on non-war construction, and building operations of any character, which were suspended by the war, may now be resumed without further permits. Chairman Baruch of the War Industries Board announced on Nov. 21 that D. R. McLennan, chief of the non-war construction section of the board, had telegraphed the order to chairmen of State Councils of Defense. This official announcement states:

"The action taken permits all building operations of whatever character, held up in the interest of the war program, to proceed. No further permits will be required from the War Industries Board or the State Councils, through whom control over the situation in each state was maintained. Immediately following the signing of the armistice on Nov. 11, the non-war construction section took steps to loosen the restraints on the industry, and in a formal order issued that day removed a great many of the barriers. Since then, and with a view to assisting the industry back to a complete peace basis as quickly as possible, a careful canvass has been made of the conditions in each state with respect to building materials, transportation, and the supply of fuel and labor. In this investigation the non-war construction section sought the views of the industry itself and of the State Councils of Defense. The replies received, coming from practically all the states, showed an unanimous opinion in favor of such action."

## Saving of Coal by Covering Boilers

A practical test of coal consumption in covered and uncovered boilers is cited by Mr. Glen D. Bagley, in a paper in the November Journal of the American Society of Mechanical Engineers. The test was made in a mine plant at Bruceton, Pa., where there were two boilers of 80 and 60 H.P., locomotive type, having 675 sq. ft. of exposed surface. The tests covered a period of 24 hours. Conditions of load, etc., were practically the same during both tests. During the first test while the boilers were uncovered, 10,784 lb. of coal was burned to evaporate 58,000 lb. of water. In the second test, after the boilers had been covered with 2 in. of 85 per cent magnesia blocks and plastic, 9296 lb. of coal was burned to evaporate 59,500 lb. of water, or 1500 lb. more water evaporated with 1488 lb. less of coal burned. If calculated for an equal evaporation of water, the saving in coal would be 1700 lb. per day. The calculated saving based on laboratory experiments was between 1400 and 1500 lb. per day. This saving amounts to 15 per cent of the coal burned due to covering the boilers alone, as the pipe lines were not included in the test.

## Liquid Wax Paint

A liquid wax paint, which is claimed to penetrate beneath the surface of wood, filling the pores with an imperishable plastic wax filler, has been placed on the market by The Reilly Co., Indianapolis, Ind. The full application can usually be made in one coat, either by means of the brush or by spraying apparatus. The paint can be applied in cold weather equally as well as in warm weather, the only requirement being that the surface be dry. This paint is also put up in a special type for waterproofing and protecting brick and concrete. The trade name of this product is weatherwax.

**Continuance of Student Army Training Corps in State Universities Recommended.**—At a meeting of the National Association of State Universities at Chicago on Nov. 12, resolutions were adopted recommending the continuance of the Student Army Training Corps until June, 1919, and a readjustment of school, college and university courses by January. A committee was appointed to place the resolutions before the war department. Speakers said that the military training of young men was necessary to a limited extent.

## Associated General Contractors of America

A new national contracting organization—Associated General Contractors of America—was formed at a convention held at Chicago Nov. 20 and 21. About 250 delegates, representing the largest contracting companies in the country, attended the meetings. The following officers were elected: President, D. A. Garber of the Northeastern Construction Co., New York City; first vice president, W. A. Rogers of Bates & Rogers, Chicago; second vice president, T. T. Flagler of the Flagler Co., Atlanta, Ga.; third vice president, John W. Cowper of the John W. Cowper Co., Buffalo, N. Y.; treasurer, C. F. Mullen of the Master & Mullen Co., Cleveland, O. The following were elected members of the Board of Directors: Noble F. Hoggedon, New York; F. J. MacIsaac, New York; C. W. Gompertz, San Francisco, and George Watson, Dallas, Texas, for 1 year term; Richard Porter, Portland, Ore., A. P. Greensfelder, St. Louis, Edward Haupt, Chicago, and Thomas Bentley, Toledo, for 2 year term; E. J. Thomas, Memphis, Tenn., L. C. Wason, Boston, M. D. Smith, Detroit, and H. B. Hanger, Richmond, Va., for 3 year term. The general offices of the association will be located in Chicago.

The objects and membership conditions are set forth as follows in the constitution:

> The objects of the Association are to promote better relations between private owners and public bodies, their architects or engineers on the one hand, and contractors on the other; to maintain high professional standards in the conduct of work; to combat unfair practices; to encourage efficiency among contractors; to support contractors and contractors' associations in efforts to rectify conditions of an unsatisfactory character; to encourage those methods of contracting for work which relieve the contractor of improper risks, and to encourage sound business methods tending to raise the standing of contractors generally in the business world.
>
> Only General Contractors, either individuals, firms or corporations, who have been engaged for at least 2 years in general contracting prior to applying for membership in this Association, or who have established a reputation for skill, honesty and responsibility, shall be eligible for membership. They must also undertake work in its entirety, partly at least with their own constructing forces.
>
> Members of the Association must be Associated Organizations of general contractors, individuals, firm or corporations engaged in general contracting. Only such members of Associated Organizations as fulfill the above requirements shall have voting representation in this Association.

## Personals

**Captain W. P. Dodge**, formerly yard foreman for the St. John's River Ship Yard Co., Jacksonville, Fla., has been appointed assistant superintendent.

**G. C. Thayer**, formerly connected with the Cramp ship yard at Philadelphia, has been appointed general manager of the Merchant Shipbuilding Corporation of Harriman, N. J.

**W. C. Wangler**, assistant city engineer of Dayton, O., has been appointed bridge engineer, to succeed George P. Baker, who at present is a lieutenant in the U. S. Engineers' Reserve.

**S. D. Moses**, heretofore resident engineer of the Southern Ry. at Alexandria, Va., has been appointed superintendent of bridges and buildings, with headquarters at Richmond, Va.

**Charles D. Weirback**, formerly city engineer of Allentown, Pa., has been promoted to captain in the army in recognition of his work as sanitary engineer at the Hog Island ship yards.

**Robert E. Kline**, formerly an engineer and contractor of Dayton, O., has been appointed district engineer for all New England coast ship yard activities of the Emergency Fleet Corporation.

**John H. Sawkins** has been appointed assistant professor in engineering, drawing, surveying and descriptive geometry at Union College. He formerly was connected with Henry Steers, Inc., contracting engineers, New York City.

**Charles P. Richardson**, assistant engineer of track elevation of the Chicago, Rock Island & Pacific Ry., has been appointed engineer of water service, to succeed J. M. Brown, who has been appointed corporation engineer of maintenance and construction.

## Obituaries

**Lieut. W. C. Ackeson**, formerly an engineer of the People's National Gas Co., Pittsburgh, was killed in action Oct. 14.

**Philip Tumulty**, a contractor and real estate operator of Jersey City, N. J., died Nov. 20. He was father of Joseph P. Tumulty, secretary to President Wilson.

**Pierre de Peyster Ricketts**, mineralogical and mining engineer, who for 34 years was professor of analytical chemistry and assaying at Columbia University, died Nov. 21, in his 71st year. He was the author of "Notes on Assaying."

## Trade Publications

**The Milwaukee Corrugating Co.**, Milwaukee, Wis., has just issued a booklet describing the uses of its products—inside corner beads—in preventing cracks in plaster. The publication contains an interesting discussion of the causes of these cracks.

*Road and Street Monthly Issue*

# ENGINEERING AND CONTRACTING

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The *articles* in the first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering and contracting field. The *articles* in the first and last issues of each month (1st and 4th Wednesdays) completely cover county engineering and highway engineering and contracting. The *articles* in the third and last issues of each month (3rd and 4th Wednesdays) completely cover steam and electric railway location, design and construction. See the "mast head" on the first page of the Weekly News Section for information about our weekly contract news.

**Roads and Streets—1st Wednesday**
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies

**Waterworks and Hydraulics—2nd Wednesday**
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power

**Railways and Govt. Works—3rd Wednesday**
(a) Excavation and Dredging
(b) Rivers and Canals
(c) Harbors and Docks
(d) Railway Construction

**Buildings and Structures—4th Wednesday**
(a) Buildings
(b) Bridges
(c) Ship Construction
(d) Miscellaneous Structures

Volume L. CHICAGO, ILL., DECEMBER 4, 1918. Number 23.

## E. & C. Index Furnished Only on Request

Hitherto it has been customary to send the index of our articles to every subscriber. In order to conserve paper the index for the six months ending Dec. 31 will be sent only to subscribers who send a postal card or letter requesting a copy of the index. It will assist us if those desiring the index will notify us at once.

## Why Federal Government Should Vastly Increase Its Appropriation for State Aid in Road Building

During the last few years this country has averaged about a quarter of a billion dollars annual expenditure for road construction, and many people have spoken of this as if it were a huge sum. The war has at least served to give Americans an economic perspective, so that we are in little danger of ever again regarding a quarter of a billion dollars annually for roads as being at all adequate. Ten times that sum would be none too large an amount to spend even in normal years. In the abnormal year of post bellum readjustment that confronts us, it would be an act of true economy were $5,000,000,000 expended for improved roads and streets in America. Huge as this sum looks, it equals only two months' expenditure for war purposes by the Federal government. There are 2,500,000 miles of roads in America, and scarcely one mile in ten is better than a dirt road. In England and in France there is not a public dirt road to be found anywhere. All are paved in some manner.

Our excuses for our disgraceful lack of an adequate system of hard roads never have been sound. We have pointed to our excellent railways, both steam and electric, and have tried to argue that their excellence excused the poorness of our roads. We have contrasted our great area with the small areas of France and England, and have tried to make out of that an excuse for our stupendous mileage of dirt roads. But all such arguments are sophistical. The plain fact is that in spite of our frequent talk about "the necessity of good roads" we have almost none, and mainly because the farmers were either indifferent or positively antagonistic to large appropriations for roads.

The automobile has at last served to open the eyes of the farmers, so we shall never again witness their opposition to road appropriations. This was well shown by the recent balloting in Illinois on the proposed $60,000,000 road bond issue, which was carried by a vote of 4 to 1. Even more striking was the result in Pennsylvania where the $50,000,000 highway bond issue was carried Nov. 5 by a majority of more than 200,000, whereas it was defeated by 40,000 five years ago.

Clearly the great majority of both farmers and city residents now favor extensive road improvement. We face a new era, we who have struggled for 25 years to arouse a lethargic public. The public is at last awake and ready to endorse any sound project for the building of an adequate system of highways in this country. The year before America entered the war we had secured the passage of a Federal road bill providing $75,000,000, to be matched dollar for dollar from the treasuries of the states. Almost none of this money has been spent. It will form "a good starter," but that is all. Congress should now be asked to multiply it by thirty, and to provide that it shall be expended as rapidly as is consistent with economy. The $75,000,000 was to have been spread over five years, but conditions have changed so greatly that thirty times that sum should be expended, not in five years, but in one year.

The Office of Public Roads is now merely a bureau of the Department of Agriculture. It should be made a department itself, for it is destined to be one of the most important branches of our government, the Department of Roads. Under the management of an able executive who is also an able highway engineer, Logan Waller Page, the Office of Public Roads has already performed important and admirable service. But the infant bureau has grown to man's estate, and should now become a separate department of the government. Roads, in common with railways, serve our agricultural communities, but they also serve every person in the land. Hence the Office of Public Roads should not remain subordinate to the Department of Agriculture.

With this change it will be evident to everyone that America at last has joined the other great nations of the world in regarding good roads as being great national assets. Who will ever again say that roads are of purely local importance? Every qualified student of the war has said that without her splendid system of national highways, France would have lost the war four years ago. The end of the war was greatly hastened by those same roads over which more than 150,000 motor trucks carried both men and supplies. At the end of September a leading German military critic, Baron von Ardenne, said:

> Circumstances are now such that only successful defense can be our aim, for the enemy can transfer reserves all over the front by means of a countless column of motor wagons; but such wealth in vehicles is denied the German command.

This is a tribute to allied and American motor trucks as a factor in winning the war, but it is equally a tribute to the foresight of Napoleon Bonaparte, for it was he who founded the system of national highways for which France has been famous for more than a century.

Entirely aside from the military need of a great system of hard roads in America there is a social and industrial need of even greater importance. Elsewhere in this issue we have quoted Secretaries Lane and Redfield on this aspect of the road problem. To make farm life more attractive there must be provided roads that will be usable every day of the year. This much is a social necessity.

Reduction in the cost of transportation is only one of the economic ends attained by building hard roads. Hoover has stated that half the perishable products of our farms rot on the farms for lack of prompt delivery to the markets. Coming from any less authoritative source such a statement would seem incredible. Coming from Hoover we may be sure that it was based on facts. Hence it is clear that the nation could spend billions of dollars to great advantage in building hard roads, if only to save the food now wasted for lack of roads that can be used efficiently every day of the year.

Secretary Lane says that the farmers unaided financially by the public can not be expected to build an adequate road system. As well expect the farmers to finance the railways as to finance the roads. The entire public should bear the financial burden of road building. In part this is now accomplished by county road appropriations, in part by state appropriations, and in part by federal appropriations. It is about the federal appropriations that we are now speaking.

The federal government since it came into being 142 years ago has expended less than $25,000,000 for roads. It really owes a stupendous debt to the states upon whose roads it has been dependent for mail deliveries and other service. It should pay that debt now and with compound interest, now when millions of war workers and millions of soldiers are available to build the roads.

A few daily paper editors of narrow vision have already begun to oppose any federal appropriations intended to provide work for men during the period of readjustment. If the work so provided were useless work, such opposition would be sound. But no one dares call road work useless. The argument is made that our returning soldiers neither expect nor need charity from Uncle Sam. True, but they will both expect and need work. They will want useful work, too, work in which they will feel the pride of real accomplishment. Such work is the building of public highways.

All our engineering societies and clubs should ally themselves with chambers of commerce and other bodies of public spirited men in urging Congress to make adequate appropriations at once for federal road work and for further federal aid to the states. The $75,000,000 already appropriated is but a pigmy purse for a giant job.

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## Who Is an Engineer?

Whoever has not studied the chapters on Definition in several works on logic can hardly appreciate what constitutes a scientific definition. Moreover, even after studying the science of defining terms, unless a person has had a good deal of practice in applying the principles laid down by the logicians, he is apt to fail in his attempts to write definitions that will meet all the logical requirements. It is often difficult enough to write an ideal definition of a class of physical things, but the difficulties multiply when the "thing" is a class of mental activity. Attempt to define "good," "beautiful," "science," "economics," and "engineering," if you wish to appreciate the inherent difficulties in specifying classes of mental activity.

To write a definition of "definition" is itself not so simple a task as it seems. Even the logicians differ in defining "definition." Yet "definition" should be itself defined before any attempt is made to write definitions. We offer the following.

An ideal definition is the most concise specification of a class, which clearly includes every member of the class yet clearly excludes every non-member.

Let us now attempt to apply this criterion to some of the definitions of engineering.

A century ago Tredgold formulated a definition that was adopted by the British Institution of Civil Engineers. It was: "Engineering is the art of directing the great sources of power in nature for the use and convenience of man."

This definition fails to specify the field of engineering, for under it may be included ordinary farming. Moreover, the definition fails to specify the directing of human energy, for the expression "the great sources of power in nature is commonly taken to mean only "external energies" such as gravitation, steam power, etc. The energy of the human mind and body is thus excluded from this definition.

The late A. M. Wellington, in his great book on the Economic Theory of Railway Location, was perhaps the first to rebel against the Tregold definition. He wrote: "It would be well if engineering were less generally thought of, or even defined, as the art of constructing. In a certain important sense it is the art of not constructing; or, to define it rudely but not inaptly, it is the art of doing that well with one dollar, which any bungler can do with two after a fashion." Wellington, it will be noted, made no serious attempt to write a scientific definition of engineering, but he performed an inestimable service in introducing the conception of the engineer as an economist.

When the editor of Engineering and Contracting wrote his Handbook of Cost Data, he decided to begin with a discussion of the meaning of the term engineering. Accordingly he framed the following definition: "Engineering is the conscious application of science to the problems of economic production." This definition may be regarded as including all classes of men who apply science in solving economic problems, whether the science be one of the physical sciences or one of the mental sciences, or any combination thereof. Among the mental sciences we have the "science of management" in so far as its psychological laws are concerned. The writer saw no need of specifying any particular science, such as management, when he had specified all science.

This definition excludes not only pure scientists, but it excludes those who apply science for other purposes than "economic production." Thus the doctor is excluded, because he applies science to alleviate suffering and secure health. The artist is excluded, for his application of science is for the purpose of producing beautiful effects. As stated in the Handbook of Cost Data, "this definition may ultimately be regarded as too broad." Thus it might be held that it does not exclude farmers who apply scientific principles, yet do not make it their main occupation to apply science. To remove this defect, as far as may be, the definition may be modified to read thus:

An engineer is one whose vocation is the systematic study and application of science to the problems of economic production.

The word "production" is to be given its broadest economic significance. The word "systematic" is introduced to make clear the fact that the "application of science" is not desultory, spasmodic or incidental.

It should be recognized at once that no definition of any class of mental activity can be framed that will perfectly define the boundary line between it and other classes, unless some more or less arbitrary division is established. Thus, to define symbolic logic so as to exclude mathematics is impossible, except it be arbitrarily decided that symbolic logic shall exclude definite quantitative terms. And so it is with every other branch of knowledge. Nevertheless, in spite of the fact that different classes of knowledge overlap or merge, it is not an idle attempt to indicate the approximate boundaries and the extent of overlap.

Mr. A. H. Krom, director of the division of engineering of the U. S. Employment Service, has written the following definition for the use of his department: "An engineer is one who economically directs man power and, by scientific design, utilizes the forces and materials of nature for the benefit of mankind." For reasons above given, this definition seems somewhat too broad. In its purport, however, it does not differ from the definition that the editor formulated in his Handbook of Cost Data. Mr. Krom has retained the Tredgold thought "for the benefit of mankind," which to the editor seems superfluous; for if the engineer directs "economically" it follows that his directing must be "for the benefit of mankind." However, it may be desirable thus to emphasize the public service that engineers perform. The two very important words, economics and science, receive proper recognition in this definition. The definition is commendable, but seems to need a clause or adjective that will lessen its scope and specify more exactly who is entitled to be called an engineer.

## The Government as Unprepared for Peace as It Was for War

Governments have a faculty of never being prepared for a radical change even when the change is in sight. From the day the Lusitania was sunk, America's entrance into the world war was prognosticated by many business and professional men. Yet two years later when America entered the conflict it entered unprepared.

From the early part of July when the allies and Americans began their uninterrupted advance that culminated in the enemy's surrender four months later, many keen observers predicted victory in the spring of 1919, and not a few were the forecasts of victory before Christmas of 1918. With victory predicted last summer by General Pershing as probable within a year, still our government took no steps to provide for the transition period of industrial readjustment following the close of hostilities. In fact even yet the government is gasping with astonishment at the end of the war, and has announced no definite policy of government aid during the imminent period of readjustment. As the "Iron Age" remarked Nov. 5:

> [illegible] done.

Just what the reconstruction work will be no one seems to [illegible]

> [illegible] high confidence in the enormous power of our industrial strength that it feels preparedness is unnecessary, and that there is no problem which our industries cannot meet, at fire alarm speed [illegible]

The president has been absorbed in war matters, and is now about to devote himself to peace negotiations. Congress, accustomed to await his leadership, has done nothing toward preparing an industrial readjustment program. All is headless, yet never was there greater need of intelligent leadership. Apparently this leadership must create itself. Organizations of business men acting in co-operation with engineering societies seem best fitted to plan the national readjustment. Civil engineering societies in particular should lose no time in asserting their leadership.

## Why Large Sums Should Be Appropriated for Public Works

Secretary of Agriculture Houston has said that highway building will be "a vital factor in the reconstruction period," and that the federal government and states have on hand $75,000,000 not expended last year, owing to the stoppage of road work. We are glad to record Secretary Houston's approval of an extensive road building program as "a worthy project for the employment of the surplus labor supply expected to result from the demobilization of the army." But when will he and other federal officials cease talking as if such sums as $75,000,000 would go far in employing men rendered idle by demobilization?

There are 4,000,000 men in our army and it is estimated that twice as many more are engaged directly or indirectly on war work. Twelve million men at $4 a day is nearly $50,000,000 a day. The $75,000,000 to which Secretary Houston refers would serve to keep these 12,000,000 men busy a day and a half!

While the government cannot be expected to provide work for all who will soon be idle, and while road work at best could keep only one or two million men busy, surely government officials and congressmen should be made to realize at once that really large sums of money must be appropriated for roads and other public works, unless there is to be much suffering during 1919.

## Who Shall Pay for Paving?

To the Editor: The [illegible] been struck by Mr. E. R. Dutton's article in your Nov. 6 issue on "Who Shall Pay for Paving?" As Mr. Dutton logically asserts, ". . . improve the street or road and the land immediately takes on an added value by reason of such improvement, and such enhanced value is attributed directly to the improvement. In other words, the improvement is a decided benefit to such land."

All forms of public progress and activity are reflected in the land adjacent thereto, and are measured by the land values. These values constitute the "unearned increment" that is now being pocketed by land owners and speculators at the expense of the public. This wealth is the easiest kind of "easy money" and has poker playing and horse racing "beaten by a block" when it comes to picking the "one-best-bet." But because we have legalized this method, by law and custom since time began, "business" men cannot see the folly of allowing landlords to pocket wealth that belongs in the public treasury. Christopher Columbus was considered a fool because he maintained that the earth is round. Henry George is considered a fool because he has maintained that our taxation-deal is not square. Being geometricians, we agree that every obtuse angle has a supplementary acute angle, and we will eventually admit that our present taxational obtuseness is supplemented by acuteness of industrial indigestion, or, in the words of Mr. Dutton, "In no city has it been successful to compel the general public to pay a very large part of the expense, as they will not stand for it, and therefore no work will be done."

Single-tax will eventually receive the same recognition as does the roundness of the earth.

THOMAS N. ASHTON, C. E.

Fall River, Mass.

# Suggests an Engineer for Mayor of Chicago

To the Editor: The executive committee of the Chicago Chapter, American Association of Engineers, in session Nov. 23, passed a resolution recommending to the public the nomination of an engineer for the next mayor of the city of Chicago.

Since there seems to be a real desire on the part of the political parties to co-operate for the good of the city and elect a mayor capable of carrying out the great construction program which will certainly begin at the close of the war, then why not select a man from the engineering profession who is fitted by education and experience to direct such projects?

Engineers are not seeking offices depending upon public patronage, but an enlightened public would do well to seek the engineer. This association has no recommendation to make nor does it enter into partisan politics, but it is confident that in a great engineering center like Chicago several engineers can be found who are fully capable of directing the affairs of the city—affairs which are to a large extent engineering problems.

It would be significant if Chicago should recognize the vital importance of the work performed by the engineers in this war by honoring the profession through the selection of one of its members for its highest office. Practically 100 per cent of the engineers of this country have been engaged throughout the war on essential and important work. It was the engineers who planned and built the cantonments, the tanks, the airplanes, the Liberty motor, the Eagles, the ships and the guns. It was the engineers "over there" who planned and built the docks, the railroads, the engines, the telephone systems, manned the signal corps, directed the artillery, constructed the bridges under fire, and fought with guns when called upon.

They have at least helped to win the war. Are they not worthy of any honor which can be bestowed upon them?

ROBT. W. SHELMIRE,
Secretary Chicago Chapter, American Association of Engineers.

**Convention of American Road Builders' Association.**—The Sixteenth Annual Convention of the American Road Builders' Association will be held at the Hotel McAlpin, New York City, Feb. 25-28. The program which is being prepared will include technical sessions every forenoon and afternoon, a dinner on one evening, an exhibition by material and machinery dealers and manufacturers, and a number of entertainments. The exhibition will be held in the roof garden and will comprise displays of models, photographs, sample of materials, and the like.

**Pennsylvania State Highway Engineers Meet.**—The semiannual convention of the Pennsylvania State Highway Engineers was held in the Capitol Building Nov. 13 and was presided over by Commissioner J. Denny O'Neil. These meetings are held for the purpose of bringing about closer co-operation among the various divisions and to acquaint the engineers with any new ideas that may have developed during the season. The men in charge of the 15 engineering districts reported that the roads are in fine shape and that the only delay, or cause for dissatisfaction, concerning road work progress has been on new construction, where contractors have been unable to secure labor or materials. However, all uncompleted roads will be put in travelable shape for the coming winter.

# Pavement Layouts Inadequate for Motor Traffic

By WM. M. KINNEY.

That a pavement may be several feet wider than the combined width of two automobiles and yet not allow those two machines to pass on a curve should be more generally realized. Motor cars in turning occupy a considerably greater width of pavement than when on a straightaway. The longer and wider the car the greater is the extra width necessary. In considering this matter it should be remembered that increasing the radius of the curve will lessen the amount that must be added to the standard straight pavement. This fact furnishes, therefore, an additional reason for constructing curves with longer radii. Since the same principle applies at street intersections, increasing the curb radius will do much toward relieving congestion, often making a narrow pavement as effective as one wider but with a short radius for the curb returns, where much of the congestion occurs at the intersections. The two photographs bring out forcefully mistakes which have been made in pavement layouts.

In Fig. 1, which shows a curve with a 28-ft. inside radius on a pavement in Chicago, 13 ft. is the width between fences. Allowing 5½ ft. for the over-all width of each automobile, 6 in. clearance at each fence and 1 ft. between the cars, one might suppose that with care the automobiles could pass. As a matter of fact, if each is turning on a constant radius, there is a circular band 3 ft. wide at the center of the pavement which must be used by both machines. This over-lapping of lanes is due to the fact that each automobile is, in effect, a rectangular body moving with the inner side tangent at the rear axle to the circle around which the car is traveling and, therefore, a width much in excess of the breadth of the machine is covered. Assuming no clearance at the fences, the width of this central strip needed by both of the automobiles remains 2 ft. To provide 1 ft. between the automobiles and the same clearance at each fence, the pavement must be 18 ft. wide. This is for cars of average wheel base—12 ft. from the rear axle to the front of the fenders.

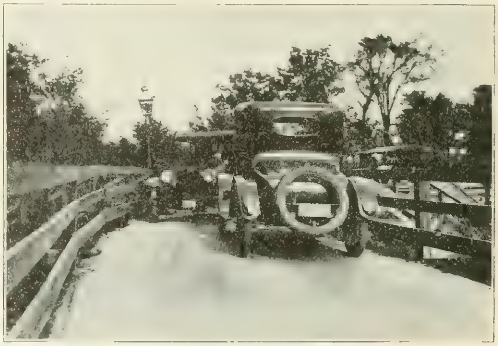
Fig. 1—Curve With 28 Ft. Inside Radius; Width Between Fences is 13 Ft.

One large truck by itself would have none too much room to keep clear of the fences, as a car with a 15-ft. wheel base and breadth of 7 ft. 6 in. requires a width of 10½ ft. On the curve under discussion with a 15-in. clearance at each side, the entire 13-ft. distance available is needed. These dimensions for widths were found from the equation: $W = R_2 - R_1$ where $R_2 = \sqrt{(R_1 + B)^2 + L^2} \times W$ is the width of pavement, $R_1$ the turning radius of the inner rear wheel, $R_2$ the turning radius of the outer front corner of the machine, B the breadth of the car and L the distance from the rear axle to the front of the fenders.

Transferring attention to the question of curb radii at intersections, it is true that considerable progress has been made in convincing engineers of the need for adopting a radius of 15 to 20 ft. as a minimum for curb returns. Yet on some of Chicago's drives used more by fast-moving motor vehicles, layouts which could easily be changed are still found, where short curb radii and abrupt turns make difficult the observance of traffic rules, whereas the natural and convenient way to drive should be, so far as possible, the lawful way.

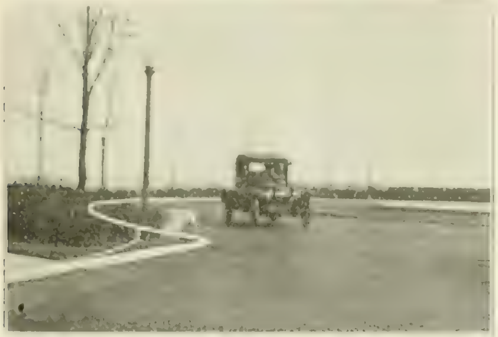

Fig. 2—Showing How Short Curb Radius Aggravates Difficulty of Turning.

For example, one instance occurs where a much-used boulevard is divided at a circular grass plot, a drive for one-way traffic only lying on each side of the large center space. Since the direction of the boulevard changes 45° at this point, traffic moving in one direction is obliged to travel farther and to turn more sharply in passing around the grass plot than is traffic in the opposite direction. As shown in Fig. 2 where an automobile is seen making one of the two reverse turns necessary in going around the longer way, a short curb radius aggravates the difficulty of turning. There is, therefore, little cause for surprise that automobilists frequently drive through on the wrong side instead of keeping to the right of the center space, even though following the former course may easily result in a collision.

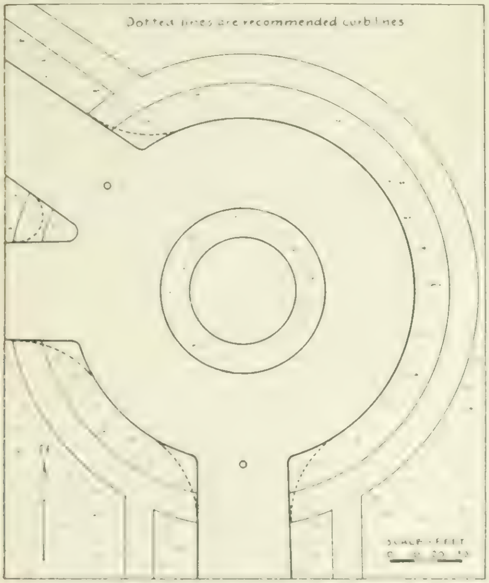

Fig. 3—Reconstruction of Curbs With Longer Radius, as Indicated by Dotted Lines, Would Expedite Traffic Movement.

Reconstruction of the curbs with longer radii, as indicated by the dotted lines, would expedite movement of traffic by making the turns more gradual and in this way lessen the incentive for using the left drive. By increasing the turning radius of the machine, centrifugal force developed would be made smaller and the likelihood of skidding thereby decreased.

The additional width provided would also be of much value. With the present curbs, only one machine at a time can pass safely between the lighting standard and the concrete barrier, so that on a drive wide enough for two lines of vehicles each way on straight sections, northbound traffic at these turns is throttled down to a single line. At present much of the paved area is never used.

Since the use of motor vehicles is ever being extended, it is essential that plans for future paving work be designed to accommodate motor traffic, and in addition, that pavements now in place be changed to conform to the new requirements, wherever possible.

## Concrete Road Maintenance Methods of Wayne County, Michigan

The following notes on the road maintenance work of the Road Commissioners of Wayne County, Michigan, are abstracted from the report of the Commission for the year ending Sept. 30, 1918:

The entire mileage of concrete roads of the county was gone over one or more times during the year, with tar, torpedo sand and granite chips, making the necessary small surface repairs to the concrete roads and tarring the joints and cracks. The Commission finds that this work can be best handled by the gang system, consisting of a foreman and about five men, who work together continuously. The sand, stone, chips and Tarvia in barrels are distributed from the nearest unloading point by the Commission's motor trucks. The tarring gang is equipped with a portable tar kettle, a team, wagon and wire brooms, shovels, tar pots and other necessary small tools. The cracks, joints and depressions up to 1 in. in depth are very thoroughly cleaned and filled flush with tar, heated to 225° F. In case of slight holes, stone chips are added to fill the depression and for joints and cracks, just sand is added, in both cases care being exercised to use just enough tar to bind the stone chips and not to bleed or push under traffic.

Where holes appear in the concrete surface or corners crack away, at expansion joints, it is the policy to make these repairs with new concrete, mixed and cured the same as the original pavement. One crew, consisting of a foreman and about eight men, makes up a very economical gang for this work. They are equipped with a small, batch concrete mixer and the necessary small tools. The plan is to dig out the concrete through its entire thickness where holes or broken places appear, and to replace with new concrete. The materials for this work are distributed by the Commission's motor trucks to convenient points along the shoulder of the road. This crew also makes any extensions or repairs to concrete culverts.

A weed cutting gang is kept organized during the entire season, starting in about the first of June, cutting weeds outside of the shoulders which cannot be reached by mowing machines. Farmers living along the line of the road are employed to cut all weeds which can be reached from the line of the road with a mowing machine.

**Caring for Traffic in Concrete Road Construction.**—On certain sections of the Washington-Baltimore Boulevard, where there were no parallel roads to care for traffic, the 20-ft. concrete pavement was put down in 10-ft. strips, one-half the road being concreted at a time, while the other half was left open to traffic. The 10-ft. strips were bound together by steel dowels 18 in. long and ½ in. in diameter. No joint opening was left and the seam where the two strips come together is scarcely visible.

# Snow Removal from Trunk Line Highways

The methods employed during the winter of 1917-18 by the State Highway Departments of Pennsylvania and Connecticut in the removal of snow from trunk line highways were described by Mr. George H. Biles, Second Deputy Highway Commissioner of Pennsylvania, and Mr. Charles J. Bennett, Connecticut State Highway Commissioner, in papers presented at a conference held Nov. 11 by the Highway Traffic Association of New York. Abstracts of the papers follow.

### Pennsylvania Methods of Keeping the Main Roads Open in Winter.

The first steps taken to cope with the situation were to provide an organization to prosecute the task efficiently. This was but an enlargement of the regular force of maintenance employes.

The division of maintenance of the department, composed of the assistant engineers, superintendents, foremen, caretakers, labor, etc., took complete charge of the snow removal work under the direct supervision of the second deputy commissioner. From the inception of this division in 1913, surveys and studies have been made of snow conditions and data compiled that have and will continue to serve in good stead, for there are many points where it has been developed that the construction of snow fence is the most economic practice. Considerable of this snow fence has been constructed up to the present time and is ready to be put in place. At present prices, this costs approximately 50 ct. per running foot in place and the design closely approximates the railroad standards.

Due to the war conditions, a new class of traffic had to be reckoned with in the United States—motor convoys—the imperative nature of which justified some of the unusual measures taken. As an example, arrangements were made with the Weather Bureau officials to wire forecasts of approaching storms to the central office at Harrisburg, which information was communicated immediately to the local forces. This affords an opportunity to anticipate conditions and organize accordingly. The War Department also wired proposed convoy movements, whose schedule was followed closely from the time they reached the western limits of the state until they passed out toward the seaboard. Stations were established along the lines of the highways at the larger towns where motor truck equipment with snow plow attachments, road machines, drags, shovels, etc., were located. The care takers or patrolmen, who were regularly employed on the road, were used as a nucleus to create the forces to handle the work. Systems of reporting were devised through telephone, telegraph and mail, depending upon the conditions, to convey to the central office the exact status of the work at all times. This information upon receipt was charted and made available at once, from which a bulletin was prepared.

Snow removal work resolves itself into snow fighting from the time the first snow makes its appearance. Work begins when heavy falls come by breaking through a track with road drags or small "V" shaped plows drawn by teams. These are followed by the road machines or motor trucks with the snow plow attachments. Turnouts are made at convenient intervals and as soon as possible thereafter the road opened to the desired width of from 14 to 18 ft., depending upon the traffic. On improved roads every effort is made to remove the snow within a few inches of the metal of the road in order that no opportunity is given the traffic to track. What snow remains that does not melt is removed entirely.

These methods apply particularly to improved roads, for if traffic is permitted to track during periods of freezing and thawing on such highways, the surface becomes affected to various degrees, depending on the type of the road. Pennsylvania has a number of miles of waterbound macadam roads with bituminous surface treatments on the main trunk lines, and in order to preserve them during such periods it is essential to distribute the traffic. On the unimproved roads the snow is not taken off entirely down to the surface, but several inches is left remaining for the travel to pack, and as it softens more snow is dragged from the sides, in order to keep the surface comparatively smooth at all times. Rolling of snow is done on the lesser important lines, but this has not been very satisfactory on the roads where there is much motor traffic, on account of the rough condition that results when the surface becomes cut up. The snow being rolled and wet from time to time with sleet and rainstorms, becomes almost as hard as ice. However, there are a number of roads where the travel is light and used mostly by horse-drawn vehicles, where this method will suffice.

In the work just described, especial attention was given to the drainage and cuts were made through the banks of snow to the ditch lines at certain intervals where possible and drains and culverts kept open and free from obstruction. This precautionary measure produced very good results, for when the snow passed away in the spring the roads had come through the winter in better shape than they had any previous time, in spite of the fact that they have been subjected to greater traffic and increased weight of loads.

The heavy drifted condition required especial treatment. Drifts were so deep and banks so high on either side of the road in some places that snow had to be shoveled and hauled out. Snows up to 12 in. in depth can be handled advantageously with road machines and from 12 to 36 in., if not too heavy, it can be moved with motor trucks with plow attachments, with excellent results. The truck is run along the one side of the highway and back on the opposite side at the rate of about 4 miles per hour and carries a small crew of men with shovels that are used when the snow piles up in front of the blade, which it will do, especially when the snow is wet. When there is a greater depth than 3 ft., a large "A" shaped plow is used. This implement is 30 in. high at the nose and 6 ft. at the back with 20-ft. legs and 16 ft. wide at the back, held together with movable braces. It is drawn by a heavy tractor, and has proven a very economical and effective device. The movable braces are provided for the purpose of permitting vehicles to pass during the operation. The light tractors for this work do not hold the road and have been found unsatisfactory. Mechanical devices are preferable in the majority of cases, but if the drifting is a continuous performance in cuts, it resolves itself into a shoveling proposition. The records for the winter of 1917-18, which covered the period from December to March, show 22 snowstorms varying in depth up to 16 in., with drifts ranging from 3 ft. to 16 ft. in depth, the general average being 4 to 6 ft. To keep the roads open under conditions similar to last winter, it costs from $50 to $200 per mile, depending upon the location and other conditions.

### Connecticut Practice in Snow Removal.

A study of the subject reveals several fundamental principles which should be recognized:

(1) That different sections of the country require different methods and degrees of snow removal.

(2) That the methods devised should take into consideration the character of traffic and the number of vehicles of different classes to be accommodated.

(3) The methods to be devised will depend entirely on the degree of removal required. For example, in the northern states where snowfalls occur, it is not necessary to consider at the present time any system of snow removal which will allow the passage of trucks, because there are few trucks which need to be operated in these sections. The amount of snow to be removed is so great as to make the cost of the work prohibitive.

On the other hand, in the Atlantic tier of states where at times the snowfall is heavy, it becomes necessary to remove the snow so as to allow the passage of motor trucks, because these trucks are numerous and important to commercial activities. The universal use of other motor vehicles for business or pleasure purposes demands the removal of snow so that the people may go about their ordinary pursuits by motor, even in the winter time.

The method of breaking our highways or for the removal of snow will depend, as noted above, on the character of traffic to be accommodated. Again, certain fundamentals should be taken into consideration in devising a system of snow removal.

The problem of the trunk highway differs from the problem of the city street, since the area to be organized is so large that no one person can comprehend the amount and character of the work to be done or personally supervise the removal of any given snowfall. Evidently snow can be more easily disposed on country roads than in the city streets. Owing also to the necessity for promptness of action, a system must be devised which will go into effect immediately upon the appearance of snow and result in the prompt removal of the necessary amount of snow, such removal to be completed within a reasonably short time after the storm and to such degree as will permit of the passage of the preponderant class of traffic. The necessary equipment for the purpose must be provided and located at convenient points so that it can go into prompt action, in many cases without notice from headquarters.

Unnecessary work may often be done, but it must be recognized that this work is emergency work and the benefits in many cases are negative.

During certain storms the telephone system is either seriously hampered or entirely put out of commission. Consequently a system of snow removal to be effective should be independent of the telephone, and the men having the operation in charge should be drilled in their duties sufficiently in advance so that they will know what is to be done and proceed with the work without delay on the arrival of a snowfall which is in excess of 3 in.

The hours of labor should not be restricted, and the time of starting should be early enough so that the forces can get the best of the storm and always keep slightly ahead of it.

The organization for this work should be elastic; the foremen or supervisors having the work in charge should have a free hand to employ the necessary men and teams to take care of an abnormal snowfall. A definite district should be allotted to each foreman, or sub-foreman, so that too much work will not rest upon one man. It is remarkable to note what an immense amount of work can be done with snow for a small amount of money, providing the work is undertaken promptly and under a systematic plan. Arrangements should be made so that the employes detailed for this work will report at headquarters as soon as a snow storm commences and remain on duty until the work is done or is shown to be unnecessary.

One of the difficulties in removing snow is that the special equipment is in many instances not suitable for other purposes, so that an endeavor should be made to adapt the ordinary road-making or maintaining machinery to the purpose of snow removal. This has been done successfully in many instances, particularly in the devising of scrapers or plows to be fixed to the front motor trucks for the purpose of removing snow from highway surfaces. These trucks are successfully operated in cases where the wheels can secure a firm grip on the road surface, but are not satisfactory in operation where the snow is allowed to drift or to accumulate to a depth in excess of 6 in., which is again an argument for promptness of action. Work should start on a continuing storm when the snow is 3 in. in depth.

Road machines may be used either drawn by horses or attached to the rear of a truck and hauled through the snow. The difficulty with road machines is the same as in the case of motor trucks—the wheels must have a bearing on the road surface in order to allow the work to be done successfully. As a matter of fact, much of the snow removal work must be done and is done using draft animals and makeshift apparatus. This applies especially to those highways where drifted snow is to be removed in order that wheel traffic may be accommodated, the first operation consisting of running a team or several teams attached to a bob sleigh over the road. Attached to the bob sleigh should be some form of plow which will break out the snow on the surface of the road, and allow a more efficient type of machine to be handled by motor truck or tractor.

In cases of highways where it is necessary to provide for the passage of horse-drawn vehicles on runners, the use of snow rollers is advisable. These snow rollers consist of heavy wooden rollers drawn by horses or oxen. The rollers compact the snow so that the travel can pass over the top. There is no practical use for this method when trucks are to be used.

The main problem before the maintenance engineers of today is, however, the removal of snow on highways to accommodate truck traffic, and the points mentioned above should be re-emphasized; namely, promptness of action to a specified plan which should go into effect without notice if the telephone fails; lack of attention on the part of the help to hours of labor or the time of day when the work is to be done; and continued service until the trouble has passed.

In Connecticut with an unusual winter the total cost of snow removal for 1917-18 was approximately $50,000 for 1,000 miles of highway cleared with varying degrees of excellence and of varying depths of snow. In general, for work of this character in this section of the country, an estimate of $45 per mile per year should be made where two lines of truck traffic are to be accommodated and the snow removed promptly.

## Causes of Failure Concrete Test Cubes

Compression tests of [illegible] concrete cubes 28 days old cast in the field, were made in 1917 by the Bureau of Tests of the New York State Highway Commission. The results of these tests are given as follows in the 1917 report of H. E. Breed, First Deputy Commissioner:

| Mix | Kind of coarse aggregate | Compression, lbs. per sq. in. | Number of cubes |
|---|---|---|---|
| [illegible] | Stone | [illegible] | [illegible] |
| [illegible] | Gravel | [illegible] | [illegible] |
| [illegible] | Stone | [illegible] | [illegible] |
| [illegible] | Gravel | [illegible] | [illegible] |
| [illegible] | Slag | 1,700 | 24 |
| [illegible] | Stone and gravel | 2,2[illegible] | [illegible] |
| [illegible] | Stone and gravel | [illegible] | [illegible] |

3,000 lb. per square inch is what is required for the 1-1½-3 concrete, and 1,800 lb. per square inch for 1-2½-5 concrete. Of the total number of cubes tested 19.6 per cent failed to meet these requirements. It is necessary to make an allowance for all cubes cast and cured during cold weather. The reason for the failures has been attributed to the following:

| | Per cent |
|---|---|
| Coated stone and gravel | 44 |
| Sand too fine or containing too much silt | 24 |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| Too wet mix | [illegible] |
| [illegible] | [illegible] |

The 1-1½-3 concrete cubes having stone for the coarse aggregate have the highest average compression strength of any year since the Commission has been testing such specimens, and while there were fewer exceptionally high breaks than in other years, the breaks in general were far more uniform. This indicates greater care in the selection of materials proper and in proportioning aggregates, and more thorough mixing, and is very creditable to the engineers handling this class of work.

The average compression strength of the 1-1½-3 gravel concrete was below that of other years. It will be noted from the table that 44 per cent of the failures is due to coated coarse aggregate, while 9 per cent is due to poor quality and excessive fine material.

## Increasing Radius of Turns at Street Intersections

The Street Department of Asbury Park, N. J., two years ago began increasing the radius of turns at street intersections in the business district. At the present time 60 corners have been rounded and it is planned to continue the work into the residential section with a view to having every corner improved before the new street paving program is taken up. In rounding the corners a radius of 10 to 18 ft. has been used; in one instance a 36 ft. radius was employed. The improvement also has been marked by a change in drainage. Outlets to the storm water drains at these corners are placed several feet from the intersection on the inside sidewalk line.

# Highway Improvement and Land Reclamation as Means for Providing for Returned Soldiers*

**Good Roads Saved Paris.**—And why has it been possible for France to carry on for four years a successful war against the greatest military power that the world has ever seen? Because France had the benefit of the engineering skill and of the foresight of two men who are 1,800 years apart—Napoleon and Caesar. Those men built the roads of France. Without those roads, conceived and built originally by Caesar for the conquest of the Gauls and for the conquest of the Teutons, without the roads built by Napoleon to stand off the enemies of France and to make aggressions to the eastward, Paris would have fallen at least two years ago. So that you gentlemen who are engaged in the business of developing the highways of the country and putting them to greater use may properly conceive of yourselves as engaged in a very farsighted, important bit of statesmanship, work that does not have its only concern as to the farmer of this country or the helping of freight movement during this winter alone, but may have consequences that will extend throughout the centuries.

**The Larger Conception Regarding Transportation.**—Now I saw my first national service in connection with the Interstate Commerce Commission and I was much impressed by the theory that the railroad men had, which was a very natural theory, arising out of their own experience and out of the fact that there was a new force in the world with which they were playing. Their conception was that the highway was a mere means of getting from the farm to the railroad, that the waterway was a mere means of carrying off the surplus waters from the hills to the oceans. The statement has often been made to me that there would never be an occasion when it would be necessary or possible to put into competition with the railroads the waterways of this country; that it would cost more to use those waterways or to use highways than it would to do the same transportation work by railroad. And they had obtained figures to show that under conditions of unlimited competition the Illinois Central, for instance, paralleling the Mississippi River, could do business at a cheaper rate than it could be transported by water, considering the cost of bringing it to the water station and unloading it at the oher end. A larger conception has come into the American mind: the conception of the utilization of all our resources. While the railroad has a great burden cast upon it; while it is the strong right arm in this work, still we must remember that the strong right arm must have fingers, and that there should be in a complete physical system a good left arm.

**Reclaim the Arid Lands and Drain the Wet Lands.**—Today the tendency is away from the farm toward the city, toward industrial life, toward aggregations of people, away from the small town to the larger town, and from the larger towns to the metropolis. People are being drawn from the farms, so that one-half of the arable land this side of the Mississippi is unused today; so that between here and New Orleans there are 40,000,000 acres of land privately owned and unused; so that in the great Northwest, Minnesota, Oregon, Washington, etc., there are 100,000,000 acres of cut-over lands that are practically unused; and we have a new nation practically in the undrained lands of our rivers and our bays and inlets, lands that are as rich as any that lie out of doors, as rich as the valley of the Nile or of the Euphrates. In the far western country there is at least 15,000,000 acres of land that we can put under water. under water that land produces more than one crop a year, and that an exceptionally rich crop.

We have been extending ourselves because of war in a great many different directions. The government has taken to itself unprecedented and unthought of powers because of the necessities of our condition. I say that to meet the problem of the returned soldier we ought to take advantage of this opportunity to do the work now that must eventually be done and reclaim these arid lands of the West. Turn the waters of the Colorado over the desert of Arizona, store those waters in the Grand River and in the Green River and let them flow down at the right times on that desert so as to raise cotton and cantaloupes and alfalfa. Then come east and take the stumps from these cut-over lands. Do it not as a private enterprise, because that is a slow, slow process. Men are discouraged and disheartened when they look at the problem of pulling an Oregon fir stump out of the ground. It really requires large capital. Then come further east and take these lands that are swamp, that need draining, and build ditches and dikes and put these lands into the service of America. This is what I call the making of the nation.

That land should tie up with all other land. Means of communication should be a part of that general scheme. We should have as good roads between the little farms in Mississippi or in South Carolina or in Northern Minnesota as we have in Maryland or in California. There is a work—the work that I have in mind, and for which Congress has made a small and tentative appropriation—the work of surveying this country and seeing how many of this nation's land resources have not been mobilized and how best they can be used for providing homes for these men who come back, as well as adding to the wealth of the world. There is a work that ties up directly with your work, because I want to have small communities in which men have small acreages of land, not to speculate with but to cultivate; and these acreages are to center in small communities where men can talk together and profit by their own mistakes and their own successes and where those small communities will be tied up with all neighboring communities so that there will be easy access between all parts of the country. Good roads and a rural express must be had. If you can help the government in building good roads for little money or show how a rural express can be most profitably developed, you will be helping in the making of a new America.

And I can conceive of a United States that will be as rich per acre as France; in which the people will be divided into small communities, industrial communities as well as agricultural; for every one of these little places ought to have its own creamery, its own cannery. The farmer is the poorest man in the world to develop any kind of cooperative scheme. He needs assistance and is always hampered by the lack of capital. But now is our chance to see what can be done; to show it in the building of ideal communities, communities that have good houses, that have good sanitation, that are on good land where there is somebody who can direct them as to what should be planted and what should be avoided, communities which may be connected up with the world by highways, by developing rivers and by railroads.

We men who are in politics today have seen our day. They are going to take charge of the politics of the United States. They are going to take charge of the social problems. They are going to insist upon industrial as well as social equality. We know that this does not necessarily mean that the nation must be run by them because they were soldiers, not unless they have the quality that gives them foresight and good sense. But now we should prepare for them. We must realize that these men are all comrades, that they are going to work together, and we ought to spread this feeling throughout the entire country. The fighting men themselves ought to get the feeling that we have who have been left behind are also in the service of the country trying to do something large for the making of this nation along real lines.

You know that there is a big man and a little man in each of us; and the little man had his day. He was the selfish, egotistic, narrow, money-making fellow. Just as soon as this country went into the war the big man came out. The big man inside of us was challenged and he arose at once and responded. And so we found railroad presidents and bankers, the automobile men and the business men of the country coming down to Washington and saying, we want our opportunity to help. It was not selfish; it was noble. And that spirit if carried out will make this country a new land in which these boys who come back will find they have been cared for; that helpfulness has come to take the place of indifference and co-operation to supplement individual initiative.

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*From an address by Franklin K. Lane, Secretary of the Interior, presented Sept. 17 at the Conference of Regional Chairmen of the Highways Transport Committee, Council of National Defense.

## Sand Spreading Device of San Francisco Street Cleaning Department

By C. W. GEIGER.

As a means of alleviating the slippery condition of streets in wet and foggy weather the street cleaning department of San Francisco spreads a coarse dry sand on smooth surface and oily pavements. The sand is spread by specially constructed devices fastened to the front end of Elgin motor street sweepers operated by the street cleaning department. The sand is carried in the carrying capacity box of the sweeper, and the spreaders are so arranged that the sand runs from the bottom of the carrying capacity box onto revolving discs, the centrifugal motion spreading the sand very evenly over the pavement.

Sand Spreader Attached to Elgin Street Sweeper. The Sand Is Thrown Ahead of the Machine.

The spreaders are operated by the street sweeper motor, being geared to it by chain. By means of two speeds, the spreaders can spread a wide or narrow space. When the spreading of sand is completed, and the machine is to be used as a street sweeper, the lower door carrying the two spreaders is removed, and the regular door placed on, and with a few other small changes the machine is ready to be operated for street cleaning.

This machine is always run over the route before parades start, spreading a layer of sand on the streets, making it easier for marchers. On foggy and wet mornings, the machine is run for a couple hours over the down-town streets, covering about 35 blocks in that time. It usually requires about 3 cu. yd. of sand to cover 35 blocks. It is then run to the yards, converted into a street sweeper, and is operated as a sweeper the rest of the day, as it takes only a short time to make the change. In making the change the chain connecting the spreader to the motor is removed, but that part of the sand spreader attached to the upper part of the carrying capacity box is left in place, as it does not interfere with the operation of the sweeper. This innovation was originated by the superintendent of the street cleaning department in San Francisco, when the slippery condition of the pavements became a serious problem. This condition is increased in San Francisco because of the fact that there is very little rain in the summer time, and the oil dropped onto the pavements by automobiles is spread and distributed by passing vehicles until the surface of the street becomes smooth and glazed. The action of the rubber on the asphalt during the summer months further tends to bring to the surface any excess oils not absorbed in the mixing at the plant. It is this oil that is absorbed by the dry sand when spread over the streets, which remedies the slippery condition. The sand is not swept up, but is allowed to remain on the street. A grade of sand is used that does not raise a dust.

## Relation of Highways to Motor Transport Efficiency*

The efficient development of highway transportation through the means of the motor truck parcel post service, return load bureaus, inter-city freight delivery, rural express and other methods of motor transportation, necessitates the utilization of highways during 365 days of the year and the construction and maintenance of good roads everywhere. The practical development of this program calls for the expenditure of vast sums of money, at least one billion dollars annually.

The cost of highways of the future is problematical. An indefinite period will elapse before the wages of labor and the cost of materials will be adjusted to normal conditions. These economic questions constitute a problem which must be given exhaustive consideration. One phase, upon which it is advisable for all to deliberate, is the sources of the unskilled labor so largely used in highway improvement. The world war has materially reduced the available supply in this country and the reconstruction of Europe will prevent the usual additions through the avenue of immigration. The belief is rapidly growing that the solution is the importation of Asiatic labor.

Today there are in the United States 2,500,000 miles of rural roads, 12 per cent of which are classed as improved. A conservative estimate would indicate that not more than one-fourth of 1 per cent of the total mileage is suitable for motor trunk highway traffic. During 1917 there was appropriated for the improvement of rural roads $300,000,000. This work is under the jurisdiction of the Federal Government, the State Highway Departments, over 3,000 counties in the various states, and the innumerable townships. The scope of this brief resume will not allow a discussion of the methods of financing highway improvement, but it is advisable to strongly emphasize the indisputable fact that it is reckless financing to construct roadway surfaces, which will have a life of 10 years, with 50-year bonds.

Today there is no national system of highways in the United States comparable to the world renowned national system of France. Indications point, however, to a rapidly developing sentiment and demand for the creation of a system of interstate highways aggregating between 50,000 and 150,000 miles which shall be constructed and maintained under the supervision and at the expense of the Federal Government. Such systems of highway as we now have are practically developed through the individual or co-operative action of our state, county and township governments, Federal aid constituting a very small percentage of the total amount expended. The development of systems in many parts of the United States is in a chaotic condition due primarily to lack or foresight and wise administration, local jealousies and ineffective laws.

Efficient and economical highway improvement has been seriously jeopardized in the United States through political interference and the placing of highway work in the hands of laymen who have had no experience in this important technical profession. Unfortunately the public neither appreciates the character of the duties of highway officials nor does it take proper interest in the expenditure of its funds. The people must be educated with respect to the complex work for which highway officials are held responsible and the waste of public funds directly attributable to having highway work in the hands of laymen. It should be emphasized that the primary objects of the educational campaign advocated are: First, the economical and efficient expenditure of the millions of dollars annually appropriated for highway work; and second, the appointment of members of the highway engineering profession to the innumerable positions of responsibility in public life which demand the combination of administrative ability, honest character, and the technical knowledge, training, and experience possessed by qualified engineers.

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*[illegible] [illegible] Association [illegible] November [illegible] "Modern Methods of Motor Transportation," held under the auspices of the [illegible] Company, [illegible] Broadway, New York City.

As in the case of many public activities, it is practicable in connection with this problem to derive valuable suggestions from practice in foreign countries. A review of their histories indicates that they have passed through the same transition period which we are entering. In France, many years ago, the people and the servants of the people realized the advantages accruing from the establishment of a permanent organization of efficient, well-trained highway engineers, and hence there was created the renowned Department of Roads and Bridges of France. Passing across the English Channel, we find similar conditions in Great Britain. In order to secure a dollar's worth for every dollar expended, the British public realized that it was necessary to have in control of their public works men trained in a profession directly dealing with every economic and engineering phase of public improvements. It has therefore inaugurated the practice of requiring that applicants for a given municipal or county position shall have attained the grade of membership in the Institution of Civil Engineers of Great Britain commensurate with the responsibility of the work of the particular office. Many leading municipal and county positions require that the applicant shall, first of all, hold the highest grade of membership in the Institution, while positions in small counties, towns and districts require in many cases associate membership. It would seem desirable in this country that a step along the line of English practice might be taken and, in the case of positions of highway officials, that there be incorporated in the constitution of a state or the ordinances of a city the stipulation that the applicant shall hold a certain grade of membership in the American Society of Civil Engineers and have had a certain number of years of experience in highway work.

The problems confronting the highway engineer of today are entirely different from those which existed 15 years ago. At that time, the motor vehicle was not a factor. Today between 5,000,000 and 6,000,000 motor vehicles use our highways, 10 per cent of which are motor trucks. Instead of constituting practically 100 per cent of the traffic as in 1903, horse-drawn vehicles at present amount to 5 to 20 per cent on highways outside of urban districts.

With the enormous developments of motor truck highway transportation, which this country is to witness in the next 5 years, many established practices in highway work must be remodeled. It is self-evident that the increased tonnage will call for ideal drainage, strong foundations and roadway surfacings suitable for motor truck traffic. In this connection may be cited the recommendation of the former New York State Department of Efficiency and Economy, in 1915, that all trunk highways should be built with cement-concrete foundations. Dependent upon the amount and character of the traffic to which a trunk highway will be subjected during the life of its surface and other factors influencing its selection, the following types are suitable: Bituminous concrete; cement-concrete; brick; and stone block.

As of particular interest to the advocates of the development of motor truck transportation is the present condition pertaining to the width of pavements on trunk highways. Reviewing the construction of the past few years of the types of pavements heretofore mentioned used on trunk highways, it is found that the widths vary from 12 to 18 ft. with a few instances of greater widths. In this connection it is of value to note that the Highway Committee of the American Society of Civil Engineers recommended several years ago that "where motor truck forms a considerable portion of the total traffic likely to use a highway, the unit width of traffic lines should be considered as 9 to 10 ft., instead of 7 or 8 ft. as heretofore." Furthermore, as far back as 1908, the First International Road Congress, held in Paris, adopted this resolution: "There should be but one roadway for every kind of vehicle, 19 ft. 8 in. wide at least." It is, of course, well known that many of the main county highways of England have an improved surface of from 20 to 22 ft. and that the main trunk highways of France are practically 24 ft. in width. When the rapid development of touring car, motor truck traffic and motor bus routes are given consideration, it is obvious that our important inter- and intra-state trunk highways should have roadway width of not less than 20 ft.

During the next few years such other factors as strengthening of highway bridges, grades, location and alignment of highways, adequate guard rails, and uniform highway signs must be given careful consideration.

The people of the United States are beginning to appreciate the fact that in order that value is received for the money expended in the construction of highways it is necessary that the highways should be efficiently maintained. Some method must be devised by which the legislatures shall annually appropriate sufficient funds to properly and economically maintain improved highways. Legislature after legislature has followed the procedure of discounting the estimates submitted by highway departments. Hundreds upon hundreds of miles of highways are today improperly maintained due to a lack of funds. It should be borne in mind that if maintenance is curtailed in one year in a given state to the extent of $500,000, and miles of highways are thereby left unrepaired, the appropriation required in the following year to repair the damage to the highways not maintained may amount to $1,000,000.

It is of vital import that uniform highway traffic laws should be placed on our statutes. Such laws must cover the physical factors and the operation of all types of vehicular traffic. Laws will be based on available data and opinions. There are, at present, innumerable investigations which should be made to ascertain facts pertaining to the interrelationship of motor truck traffic and the durability and serviceability of highways. If highway departments do not conduct such investigations, they should be undertaken at once by motor truck interests. If the essential data is not available, naturally traffic laws will be based upon conservative conclusions reached by highway officials and members of our legislative bodies.

## Cost of Hauling with Teams

The accompanying table prepared by Mr. E. B. Hiatt, engineer of Madison County, Iowa, has been of service in estimating the cost of team hauling on work for that county. The figures are based on a rate of travel of 2 miles per hour with loads and 3 miles per hour returning empty. Forty minutes is allowed for loading and unloading 3,750 lbs. with shovels. This weight was the average load last season. The vehicle considered was a common farm wagon. A comparison of the schedule with the flat rate of 1 ct. per bushel per mile for hauling wheat in northern Iowa and southern Minnesota shows that at 11 miles the rates are practically the same, while at 5 miles the county would pay $.138 more, and at 15 miles $.085 less.

SCHEDULE OF PRICES FOR HAULING ONE TON.

| | Team rates per day of ten hours. | | | | | |
|---|---|---|---|---|---|---|
| Miles. | $5.00 | $5.50 | $6.00 | $6.50 | $7.00 | $7.50 |
| 0.5 | .288 | .317 | .346 | .375 | .404 | .433 |
| 1.0 | .400 | .440 | .480 | .520 | .560 | .600 |
| 1.5 | .511 | .562 | .613 | .664 | .715 | .766 |
| 2.0 | .622 | .684 | .746 | .808 | .871 | .933 |
| 2.5 | .733 | .806 | .880 | .953 | 1.026 | 1.100 |
| 3.0 | .844 | .928 | 1.013 | 1.097 | 1.182 | 1.266 |
| 3.5 | .955 | 1.051 | 1.146 | 1.242 | 1.337 | 1.433 |
| 4.0 | 1.066 | 1.173 | 1.280 | 1.386 | 1.493 | 1.600 |
| 4.5 | 1.177 | 1.295 | 1.413 | 1.531 | 1.648 | 1.766 |
| 5.0 | 1.288 | 1.417 | 1.546 | 1.675 | 1.804 | 1.933 |
| 5.5 | 1.400 | 1.540 | 1.680 | 1.820 | 1.960 | 2.100 |
| 6.0 | 1.511 | 1.662 | 1.813 | 1.964 | 2.115 | 2.266 |
| 6.5 | 1.622 | 1.784 | 1.946 | 2.108 | 2.271 | 2.433 |
| 7.0 | 1.733 | 1.906 | 2.080 | 2.253 | 2.426 | 2.600 |
| 7.5 | 1.844 | 2.028 | 2.213 | 2.397 | 2.582 | 2.766 |
| 8.0 | 1.955 | 2.151 | 2.346 | 2.542 | 2.737 | 2.933 |
| 8.5 | 2.066 | 2.273 | 2.480 | 2.686 | 2.893 | 3,100 |
| 9.0 | 2.177 | 2.395 | 2.613 | 2.831 | 3.048 | 3.266 |
| 9.5 | 2.288 | 2.517 | 2.746 | 2.975 | 3.204 | 3.433 |
| 10.0 | 2.400 | 2.640 | 2.880 | 3.120 | 3.360 | 3.600 |
| 10.5 | 2.511 | 2.762 | 3.013 | 3.264 | 3.515 | 3.766 |
| 11.0 | 2.622 | 2.884 | 3.146 | 3.408 | 3.671 | 3.933 |
| 11.5 | 2.733 | 3.006 | 3.280 | 3.553 | 3.826 | 4.100 |
| 12.0 | 2.844 | 3.128 | 3.413 | 3.697 | 3.982 | 4.266 |
| 12.5 | 2.955 | 3.251 | 3.546 | 3.842 | 4.137 | 4.433 |
| 13.0 | 3.066 | 3.373 | 3.680 | 3.986 | 4.293 | 4.600 |
| 13.5 | 3.177 | 3.495 | 3.813 | 4.131 | 4.448 | 4.766 |
| 14.0 | 3.288 | 3.617 | 3.946 | 4.275 | 4.604 | 4.933 |
| 14.5 | 3.400 | 3.740 | 4.080 | 4.420 | 4.760 | 5.100 |
| 15.0 | 3.511 | 3.862 | 4.213 | 4.564 | 4.915 | 5.266 |
| 15.5 | 3.622 | 3.984 | 4.346 | 4.708 | 5.071 | 5.433 |
| 16.0 | 3.733 | 4.106 | 4.480 | 4.853 | 5.226 | 5.600 |
| 16.5 | 3.844 | 4.228 | 4.613 | 4.997 | 5.382 | 5.766 |
| 17.0 | 3.955 | 4.351 | 4.746 | 5.142 | 5.537 | 5.933 |
| 17.5 | 4.066 | 4.473 | 4.880 | 5.286 | 5.693 | 6.100 |
| 18.0 | 4.177 | 4.595 | 5.013 | 5.431 | 5.848 | 6.266 |
| 18.5 | 4.288 | 4.717 | 5.146 | 5.575 | 6.004 | 6.433 |
| 19.0 | 4.400 | 4.840 | 5.280 | 5.720 | 6.160 | 6.600 |

# Methods and Cost of Maintenance of a 27 1-2 Acre Park System

BY H. R. FERRISS

The following costs cover the maintenance from Jan. 1st to Nov. 15th 1918 of a park system, comprising 27½ acres, of which approximately 4 acres are in small parks and the balance in narrow boulevards along the edge of pavements, and containing the usual improvements such as light standards, hydrants, etc., found in city boulevards. These improvements, together with the cross streets (owing to the fact that they interfere with "straight" work), add, of course, somewhat to the cost of maintenance. Included under the work of maintenance are 308 boulevard trees, approximately 3,000 shrubs of various kinds, 3,500 feet of dwarf hedge, and 1,250 feet of privet and broom hedge.

The grass cutting is done with a 32 in. horse drawn lawn mower, followed by a 16 in. hand mower which cuts those places inaccessible to the horse mower. The man operating the hand mower also trims the edges along walks and curbs, around standards, etc., using for this purpose long handled grass shears. The grass cutting was commenced on March 25th and carried on without intermission until Sept. 30th. The entire grass area is covered every 6 days at least, and this close cutting, we find, is our best protection against the spread of weeds on the boulevards.

The watering, during the five dry summer months, is done by a crew of high school boys, who work between 5 and 10 p. m. every day except Sunday. The grass areas are divided into districts of varying sizes, which are carefully planned according to locality, soil, etc., in order, that each member of the crew may have, as nearly as possible, an equal amount of work. The hose connections are spaced 150 ft. apart and "staggared" on opposite sides of the street. Each member of the crew operates one section of hose with a hand sprinkler and from one to three sections with automatic sprinklers attached. The sprinklers, which are homemade, are designed to give the maximum volume consistent with minimum water waste. On wide areas a high revolving sprinkler is used and on the narrow boulevards a sprinkler lying on the ground which covers the grass only between the curbs and margins. Each member of the crew looks after his own hose and tools, and for which he is held strictly responsible. The occasional repairs to the water connections are made by the "handy man" employed on the estate.

A generous bonus is paid for the two best kept sections, and a system of fines is imposed for carelessness, water waste, damaged hose, etc. In passing, it may be worth mentioning that this system of fines and bonuses has been in force for 3 years and on the whole has been satisfactory.

The water used for sprinkling is shown in Table II.

The shrubs, hedge, etc., are maintained by one man, working less than full time. The dwarf hedge is trimmed (on top) once a year with a lawn mower mounted on wooden wheels to give the required height, and (the sides) with hand shears.

A limited amount of strictly necessary weeding is done in the spring, when the ground is still soft from winter rains. Weeding is never done in summer when the ground is hard, owing to the difficulty of removing the roots. Every fall, after grass cutting is complete, good manure is spread on grass areas, and at the base of a certain number of trees and shrubs.

The cost of maintenance varies considerably with the weather. During the past 5 years, the average summer rainfall has been 2.72 in. from April 1st to Oct. 1st, but each year there are at least two months when practically no rain falls during those two months. It is then nearly as dry, although not as hot, of course, as Southern California. We regard a good soaking rain in summer worth at least $50 to the company.

There is, in places some wild land bordering the boulevards, which makes a splendid nursery for dandelions. In order to prevent as far as possible the seeds from blowing into the boulevards and also to choke out the dandelions, we planted broom and lupin, both of which thrive in this locality, and require little or no care. They give a good appearance and require very little labor to re- [illegible] produce themselves in the areas infested with weeds. The total original cost of this planting to date has been under $90, and the results, practical and ethical, have been highly satisfactory.

In the following costs (Table I) the rates are assumed, but the hours and quantities are correct. The costs are net and do not include depreciation, office, overhead, etc. Maintenance only is included, new work of all description having been omitted.

On the basis of the rates given in Table I the total cost for all labor connected with maintenance works out to about $67.20 per acre.

For the fertilization good manure was previously dumped (under contract) at convenient points adjacent to the backward grass areas. This labor item in Table I includes only the handling from stock piles.

The miscellaneous labor item in the table is for special watering on trees and backward areas.

In the weeding a long handled weeding fork designed by the Superintendent is used. Special care was taken to extract roots, and all weeds were promptly burned. The holes were sprinkled with grass seed.

TABLE I—LABOR COST OF MAINTAINING PARK SYSTEM

| Labor classification. | Hrs. | Rate. Ct. | Cost | Unit cost. |
|---|---|---|---|---|
| Fertilization (13,200 sq. yd.) | | | | ....49 ct. per 100 sq. yd. |
| Labor spreading [illegible] [illegible] | [illegible] | [illegible] | [illegible] | |
| Labor [illegible] | [illegible] | [illegible] | [illegible] | |
| Grass cutting (27 acres) | | | | .$20.30 per acre |
| Horse mower | [illegible] | [illegible] | 158.50 | |
| Hand mower (including trimming) | 1,298 | 30 | 389.40 | |
| Watering (27½ acres) | | | | $[illegible] per acre |
| Labor (includes care of hose, etc.) | [illegible] | [illegible] | [illegible] | |
| Repairs to boulevard connections | [illegible] | [illegible] | [illegible] | |
| Miscellaneous labor..... | 225 | 30 | [illegible] | |
| Care of boulevard trees (308 trees) | | | | .21 ct. per tree |
| Pruning | 42 | 40 | 16.80 | |
| Spraying | [illegible] | [illegible] | 19.80 | |
| Re-tie and re-stake..... | 52 | 30 | 15.60 | |
| Fertilize (includes [illegible]) | [illegible] | [illegible] | [illegible] | |
| Care of hedges (4,750 lin. ft.) | | | | [illegible] per [illegible] |
| Pruning, clipping, etc.. | 56 | 40 | [illegible] | |
| Cultivating and weeding | [illegible] | [illegible] | [illegible] | |
| Care of shrubs (3,000 shrubs)..... | | | | $1.67 per 100 |
| Pruning ................ | 98 | 40 | [illegible] | |
| Cultivating ............ | 36 | 30 | [illegible] | |
| Weeding (about 27 acres) | | | | $3.90 per acre |
| Labor .................. | 261 | 30 | [illegible] | |
| Care of park tools (other than hose) ............ | 149 | 40 | [illegible] | $2.17 per acre |
| Miscellaneous labor ...... | 53 | 30 | [illegible] | [illegible] per acre |
| Superintendence (proportional charge) | [illegible] | [illegible] | [illegible] | $1.[illegible] per acre |
| Total | | | $1,[illegible] | |

The water used for sprinkling is given in the following table. It should be noted that the boulevards, towards the end of the season, got brown in spots—at one time about 8 per cent of the total area showed brown—but the first hard rains in early fall restored the grass. The precipitation is given owing to its close relation to the quantity of water used.

TABLE II—WATER USED FOR SPRINKLING

| Month. | Precipitation In. | Water used [illegible] | Remarks. |
|---|---|---|---|
| April .... | [illegible] | 1,750 | [illegible] ins[illegible] crew [illegible] |
| [illegible] | [illegible] | 6,000 | [illegible] four. [illegible] |
| [illegible] | [illegible] | 11,100 | Watered [illegible] |
| [illegible] | [illegible] | [illegible] | Watered [illegible] |
| [illegible] | [illegible] | 3,500 | Watered [illegible] crew [illegible]s, and [illegible] |
| September | [illegible] | [illegible] | Watered [illegible] |

About 60 per cent of the area watered is grass over a sandy gravel sub-soil, on side hill location which increases run-off. The balance is grass over a clay sub-soil. [illegible] about 60 per cent the quantity of water was required on clay sub-soil to keep the grass in as good, or better, condition than that on sandy sub-soil, particularly where the boulevards follow sloping ground.

## Speedy Resumption of Federal Aid Road Construction and Increased Federal Appropriations Advocated by Secretary Houston

Co-operative highway construction under the Federal aid road act must be resumed as quickly as possible in full measure, the Secretary of Agriculture, D. F. Houston, stated at a conference of editors of agricultural journals held recently at Washington.

From unexpended balances of Federal appropriation for the last few years, from State funds beyond what was necessary to meet the Federal allotments, and from amounts available during the current fiscal year, approximately $75,000,000 will be available for expenditure during the calendar year. Next year, if all the balances should be expended during this year, and we should have to rely solely on the funds accruing next year, there will be $20,000,000 from Federal appropriations, and probably more than this amount from State sources, according to the Secretary's statement. The States, in addition, will expend sums in excess of what they have assigned, or will assign, for Federal aid road projects. Secretary Houston said:

> It seems to me that we should take a further step—take this step not only because of the importance of good roads, but also because of the desirability of furnishing worthy projects on which unemployed labor during the period of readjustment may be engaged. There will be many things suggested for which Federal and State funds will be sought. Some of these will be unworthy. Clearly such public works as roads are worthy, and it would be in the public interest to make available larger appropriations from the Federal Treasury to be used separately or in conjunction with state and local support.
>
> There need be no delay in the execution of such a program. The Nation has already provided the machinery in the Department of Agriculture and in the State highway commissions. The Federal aid road act was fruitful of good legislation, and each State in the Union now has a central highway authority with power and funds to meet the terms of the Federal act. The two agencies, in conjunction, have been engaged in devising well-considered road systems and in making surveys, plans and specifications. The task will be one of selection, and those roads should be designated for improvement which are of the greatest economic importance, with due regard to such military and other needs as are proper for consideration. There is no necessity for any departure from this scheme. The suggestions made have been canvassed with the President, the Secretary of War and the Postmaster General, and they are in accord with the view that additional funds should be made available to this department and that they should be expended through existing machinery.

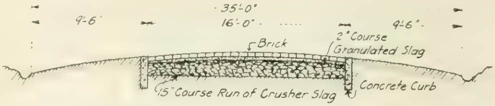
**National Highway Traffic Association Organized.**—At the November meeting of the Highway Traffic Association of the State of New York, held at the Automobile Club of America, many Government, state, county and municipal officials and officers of several organizations interested in highway problems participated in the formation of the National Highway Traffic Association. The object of the new organization is the advancement of the efficiency and regulation of highway traffic. The Association will publish reports, standards and regulations adopted by it and will promote sound legislation pertaining to highway traffic. Besides the usual executive officers, there will be five Vice-Presidents representing different sections of the United States, and a Director from each state and territory of the Union. Professor Arthur H. Blanchard of Columbia University, New York, is President of the new Association.

**Concrete Shoulders for Widening Macadam Roadway.**—Certain sections of the highway between Washington and Baltimore, Md., are being widened by building concrete shoulders on both sides of the macadam. These shoulders are 3 ft. wide and 8 in. thick, and make the total width of the road 20 ft.

## Blast Furnace Slag Used for Base and Cushion of Brick Pavement on National Highway

Blast furnace slag was employed for the base and cushion course of a 13¾ mile section of the National Highway completed recently between New Concord and Zanesville, O. This highway section was rebuilt by order of the Government as a necessary war measure. The grading was begun March 22, 1918, and the road was opened to traffic on Oct. 22.

The original earth road was carefully graded by wheel scrapers and low grades filled and the necessary cuts made. Then forms for concrete curbs were built to form a curb 30 in. deep by 6 in. in width. After removal of forms, there was laid between curbs a 15 in. course of run of crusher slag, from Bellaire Furnaces, Carnegie Steel Co. After this had been thoroughly rolled and bonded, sufficient granulated slag from Riverside Furnaces of the National Tube Co. at Benwood, W. Va., and the Wheeling Steel & Iron Co., Wheeling, W. Va., was placed to fill up the interstices in the slag base. This course was then also thoroughly rolled and compacted. On the slag bed thus prepared was laid a 2 in. cushion course of the same granulated slag carefully leveled, on which was placed 4x9 in. paving brick. Bricks were laid in record time, the crew of two bricklayers and helpers laying as many as 54,000 bricks a day.



Cross Section of East Pike Section of National Highway.

The work was carried out under the personal supervision of R. C. Burton, of Zanesville, who was appointed to represent the State of Ohio. A critical labor shortage materially delayed operations earlier in the season. The labor problem was met in part, by the employment of Mansfield and Lancaster Reformatory prisoners who were well paid, amply provided with food, shelter and clothing and granted almost absolute freedom while on the job.

On either side of the paved section, which is 16 ft. in width, are well drained and rolled berms, 9 ft. wide, which provide excellent driveways for horse drawn vehicles.

The materials used in constructing the road were 5,000,000 Townsend brick, 306 cars of run of crusher slag, from Carnegie Steel Co., 258 cars of granulated slag from the National Tube Co. and Wheeling iron and steel company, 216 cars of native gravel, 8,343 bbl. of Crescent Portland cement and 1,000 tons of tar from the Barrett Manufacturing Co.

**Expansion and Contraction in Concrete Roads.**—An investigation was started last year by the New York State Highway Commission for the purpose of determining the expansion and contraction of the concrete in concrete roads. Six sets of reference plugs were placed in four different concrete roads in March and exact measurements taken over the spaces marked off by these plugs. Measurements were also taken on May 4, May 31, July 31, Oct. 8 and Dec. 4. There was an average change in the length of the concrete of about 0.02 per cent, the greatest length being recorded on July 31st and the minimum length on Dec. 4th. In connection with this expansion and contraction in the concrete, it should be noted that the year 1917 was deficient in both precipitation and temperature The precipitation deficiency amounted to 7.72 in. and the deficiency in temperature amounted to 665° F. Both of these factors have a tendency to decrease the expansion and contraction of concrete.

The Great Lakes Dredge & Dock Co., at $5,300,000, was low bidder for work on the Michigan Ave. boulevard link, Chicago.

# The Three Elements of Transportation: Highways, Railways and Waterways*

The transportation system of the United States is not a unit. It cannot be run on what we may call unitarian lines.

It is a trinity, and has to be run on trinitarian lines. You must link up railways and waterways and highways to get a perfect transportation system for this country. If there were no railroads we would have little transportation. If there were no waterways there would be insufficient transportation. If we had an abundance of railways and waterways and lacked the use of highways, we should have imperfect transportation. We should fail to bring it to every man's door, and it must be brought to every man's door to be perfect.

It is within two years that the governor of a great state has suggested to me that the use of large motor trucks be forbidden because they destroy highways. I ask you if you will warrant the removal of locomotive engines because they are made 100 tons heavier and would break the light rail made 40 years ago. The problem is a duplex one. The best tool must be had for the job and the opportunity must be provided for the tool to do its work.

**Internal Combustion Engine and Highway and Waterway Transportation.**—There came into the world a new tool: The internal combustion engine, destined to work almost as great a change in the human life as the steam engine in its time, making possible a tool for the waterway that the waterway had never had before, making it possible to use for the highway what the highway had never had before, making necessary the alteration of the highway to suit the new tool built for it. It has never been true until now and it has just now become true that the waterway and highway have been, as regards the tools for their use, on a technical and scientific level with the railway. The Government is just putting in operation this month the first great barges for the Mississippi river, intended to carry ore south and coal north, made possible because of internal combustion engines. The tool has come, the internal combustion engine is altering the face of the marine world, so that we do not really need but 6 ft. of water in the northern Mississippi to carry 1,800 tons of ore in one boat. We look upon the development of the New York state barge canal with a certainty of its profitable use for the nation, for with a 12-ft. draft we know we can carry 2,500 tons in any vessel constructed for the purpose, driven by internal combustion engines. The tool for the job and the way made ready for the tool.

**Highways as Feeders for Waterways.**—My conception of the future of the New York barge canal and the canal across New Jersey and the Chesapeake and Ohio and all the waterways is that the companies operating on them shall pick up and deliver at every important terminal point by lines which shall radiate out by motor trucks from 50 to 100 miles and they shall take from these places goods thus brought to their station. So that if when, for example, they were delivering goods from Kentucky to Illinois, the goods might start from a farm or from an inland village by motor truck and go to the nearest waterway station, there to be picked up by vessel and be carried down the Kentucky and Ohio to a point sufficiently near in Illinois to where it was to go, there to be picked up by motor trucks which would carry it to its destination. And it should be billed through by one bill of lading. That would definitely establish that the vehicle and highways are not accidental or incidental, but an essential factor. That, it seems to me, is what we are coming to before very long. I imagine we will come to it almost before we think of it.

**Rural Express.**—Our friend the farmer must have the Rural Express or its equivalent which comes to his door, which in the morning connects him up with all the round earth and brings him what he wants of the earth's products back to his door that night.

I cannot think of that except as a matter of [illegible] sense. It is a thing which has got to be, and in a very few years, at least, will be as accepted as such things as the rising of the sun and the setting of the sun. It will be considered normal. You will even find, if you have not already found, farms offered for sale on the basis of having a Rural Express coming and going on one side of it, perhaps on two sides of it as we get into it more thoroughly. The whole rural postal delivery system was the promise and pledge of the Rural Express. What we do when we send the motor truck through the rural centers is to push the Rural Free delivery and the parcels post service just one step forward.

So many are familiar with the automobile, not as familiar, I believe, as they are going to be, that it seems hard to think it can work as revolutionary a change in their life as it is going to do. But I am perfectly certain that there abide these three elements of transportation, railway, waterway, and highway, that they are one, and that none of them will reach its full value to the community without the other and that each is the friend of the other.

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*From an address by W[illegible] C. Redfield, Secretary of Commerce, presented before the [illegible] of the Highway Transport Committee of the Council of National Defense.

# Government Motor Truck Routes

A plan for the utilization of the men now in the army for an extensive development of the motor truck parcel post routes was outlined by Mr. James I. Blakslee, Fourth Assistant Postmaster General of the United States at the November meeting of the Highway Traffic Association of the State of New York. He proposed "that we use the available military equipment, and such available military personnel in the construction and operation of a governmental enterprise that will be immediately profitable, and which, in turn, will produce sufficient revenue to continue its administration and operation."

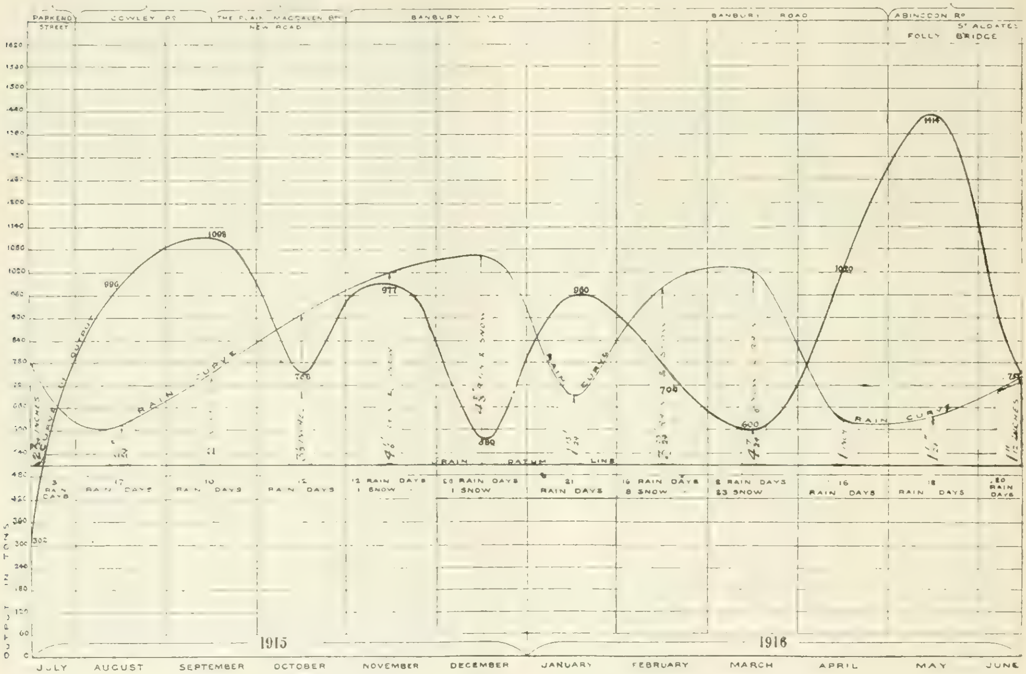
Mr. Blakslee further stated:

> I am informed that there are [illegible] motor vehicles now in use, or in process of construction for military purposes. I am certain that a large number, if not the majority of these motor equipments, can be utilized in the transportation of [illegible] and commodities through territory within the country that is not immediately adjacent to existing means of transportation, and is located in productive localities where inadequate means of conveyance obtain. To properly utilize such an enormous number of moving units would require the service of an equally huge army of individuals, and thereby provide employment for thousands of men who have been making a sacrifice for us all.
>
> I believe that there should be three different methods of meeting the cost of the construction and maintenance of highways.
>
> First: For a highway entirely Federal or national in character. This main line, or through connecting national highway, should be utilized by the Federal government in the transportation of commodities upon which a revenue should be earned sufficient to meet the expense of transportation, and to provide for the improvement and maintenance of the roadway over which the commodities are collected and I [illegible] a specific method, one that we have tried and found profitable, the conveyance of mailable matter, including parcel post, at regular rates. There are in operation today transportation facilities in daily operation on through or connecting highways from Portland, Me., to Richmond, Va.; from New York City to Chicago; from Indianapolis, Ind., to Montgomery, Ala.; and with an appropriation of $300,000, the postage revenues on these highways [illegible] 000,000 per annum.
>
> Second: For a highway supported by the Federal Government and the states and local sub-divisions thereof. These highways should be known as feeder highways and located near trunk lines, or national highways, within producing territory.
>
> Third: For a highway supported by the county and township. This third definite suggestion includes the construction and maintenance of supply roads to the feeder roads that finally connect with the National trunk line roads.
>
> The benefits of [illegible] construction can be extended to include the cost of living, for, through the complete organization of a system of transportation [illegible] that have today reached exhorbitant figures can be influenced to a considerable extent. [illegible] selling in the city of Newark, N. J., at $1.00 per dozen, when a tremendous supply was available at New Holland, Pa., a distance of 100 miles from Newark, at 60 ct. per dozen. With a postal rate of about 3 ct. per dozen, we could have possibly delivered [illegible] per dozen less than the price the citizens were paying.

# Asphalt Pavement Construction in Rainy Weather

Interesting observations on the construction of sheet asphalt pavement during rainy weather are given by Mr. T. G. Marriott, engineer the Limmer & Trinidad Lake Asphalt Co., Ltd., in a recent issue of The Surveyor. In his article, an abstract of which is given below, Mr. Marriott gives information collected during the carrying out of a paving contract for the corporation of Oxford in 1915-1916.

The work comprised the laying of about 5 miles of 4½ in. Trinidad asphalt macadam on the principal motor omnibus routes of the city. The asphalt was laid in two coats direct upon the existing roadbeds after the usual scarifying and rolling to required levels. No Portland cement concrete was used throughout the contract, the conditions of which provided for the continuous prosecution of the work during the winter months, subject to the discretion of the City Engineer.



Rainfall and Monthly Output of Asphalt from Paving Plant.

The contractors arranged with the principal of the Radcliffe Observatory, Oxford, for the monthly record of weather statistics, and of these the number of rainy days and total rainfall are presented in chart form, together with the corresponding monthly output in tons of asphalt mixture from the paving plant. The latter was of the company's small, semi-portable type, consisting of twin "Rotosec" dryers, 10 ft. by 10 ft. mixing tower and three portable bitumen tanks. The plant was driven by a 15 h. p. steam engine, and was situated on a railway siding, an average distance of 1½ miles from the site of the work.

A reference to the chart will show that the contract was spread over 11 months, and thus embraced a cycle of the seasons. Allowing for the reduced hours of daylight in the winter months, it will be seen that a fair output was maintained from the plant, the abnormal March (the wettest with one exception in 100 years according to the observatory records) being the sole period during which the weather prevented the manufacture and laying of the asphalt.

While in the total the mean rainfall of Oxford is not greatly in excess of that of London, the winter climate of the city is by no means a favorable one for the laying of asphalt, being for the most part damp and raw, with occasionally extremely low temperatures. The subsoil of the roads was found to consist largely of valley gravel, and was thus of good quality for the work. On the whole, however, the asphalt laid in the winter months at Oxford bears favorable comparison with that laid in the summer, and the writer sees no reason to doubt the efficacy of modern two-coat asphalt constructed during moderately rainy weather.

Given the essentials of a suitable sub-foundation and particularly a well-designed asphaltic concrete base, it would seem that the wearing surface or "topping" may be put down in any conditions of weather that the workmen engaged in laying it can tolerate. On the other hand, the prejudice of engineers against the laying of compressed rock asphalt in any but the most favorable weather conditions is probably justified by the fact that this type of asphalt is always put down in a single layer upon a Portland cement concrete foundation, and is somewhat absorbent of moisture until full compression under traffic is obtained.

**Asphalt and Water Absorption:**—The difference between rock asphalt and mechanically-mixed asphalt in regard to water-repellency at the time of laying is sharply brought out by a laboratory experiment the writer recently carried out. A small amount of each kind of asphalt was taken in a loose condition and agitated in an equal quantity of water for 30 sec. in a test tube. The rock asphalt (Sicilian) contained 10.5 per cent of soluble bitumen. The mechanically-mixed asphalt contained 11.7 per cent soluble bitumen (Trinidad). After agitation, both samples were allowed to filter for 1¼ hours. At this point the rock asphalt showed 67 per cent of moisture and the mechanically mixed asphalt 29.9 per cent. The samples were then placed in an air bath at 220 Fahr. for half an hour. It was then found that the mechanically mixed asphalt had thrown off all its moisture with the exception of 2.[illegible] per cent, while the rock asphalt powder still held 29.8 per cent. Thus it will be seen that not only was the rock asphalt in this condition far more absorbent of water, but that it gives off its moisture more slowly than the mechanically-mixed asphalt.

These conclusions are in no way intended to impugn the quality of compressed rock asphalt. On the contrary, the writer believes this type of construction to represent the highest standard of asphalt paving for heavy traffic. It is merely intended to put forward reasons why the prejudice of engineers against the laying of rock asphalt in rainy weather need not necessarily be extended to the modern two-coat mechanically-mixed asphalt. This latter form of asphalt, consisting as it does of fine particles coated with an adhesive film of bitumen is obviously more water-repellent at the time of laying than rock asphalt powder with its light impregnation of bitumen, and thus lends itself more readily to successful application during rainy weather. Moreover, in the two-coat work the bottom layer of asphaltic concrete or "binder" acts as a key for the wearing surface or "topping," even when rain is falling, and also serves to a large extent to drain away any surface water.

## Providing for Returned Soldiers

I have thought of the men who will come back after the war. Every nation has had a problem to deal with the returning soldier. If you read Ferraro's history of Rome, you will find that one of the chief reasons why the republic of Rome went out of existence and the empire of Rome came into existence was because of the returned soldiers. They looked to their general to take care of them on their return, and their general found that the way to take care of them was to give them, as they said in those days, "bread and circuses," and so they reached over into Egypt, got the great wheat supply of that country, and provided the great circuses that are historical, for the amusement of those people.

The emperor of Germany 10 years ago was asked why he was unwilling to agree to a demobilization of his forces or to a reduction of his army and he said because it would demoralize the industries of Germany. They could not reabsorb so many men without reducing wages and throwing upon the country so many unemployed that it would make aganist the welfare of the land. We will have that problem to deal with.

Now that this thing is over our men will begin to come back into the United States. But not all at once. We won't have three or four million men to deal with in a single month. We will have them slowly returning to us through a year or a year and a half. As those men come filtering in through our ports we ought to be able to meet every man at every port with the statement that he does not have to lie idle one single day. We ought to be able to say to the man, "Here is something that you can do at once. If your old position is not vacant, if you cannot go home to the old place and take up the work that you were in, then the government of the United States, in its wisdom, has provided something which you can do at wages upon which you can live well."—From an address by Franklin K. Lane, Secretary of Interior, at a conference Sept. 17 of the Regional Chairmen of the Highways Transport Committee, Council of National Defense.

**Post-War Priority in Great Britain.**—The British Government has appointed a standing council upon post-war priority to consider all questions connected with priority and the allocation of materials and machinery where a shortage is to be anticipated. The Council will consist of representatives of industry and commerce and of labor, together with representatives of certain Government departments, and upon broad questions of policy will be under the direction of a Committee of Ministers. Representative bodies of the industries concerned will be consulted by the Council.

# Road Maintenance Costs in Washington

During the 12 months June 1, 1917, to May 31, 1918, a total of $41[illegible] was expended for highway maintenance on the primary state routes of Washington. This makes an average expenditure of $327.84 per mile for all classes of highways. This figure, stated Mr. J. [illegible] Cotterill, Chief Engineer of the Washington State Highway Commission, in a paper presented before the Joint Convention of the Washington County Highway Engineers and Commissioners, is believed to be high on account of the fact that in anticipation of the new maintenance law becoming effective June 7, 1917, practically all the spring maintenance was held up until that date. Thus the heavy maintenance for two spring periods was carried on in one year. The present high prices have also had their effect upon the figures, and Mr. Cotterill believes under normal conditions the annual charge may be brought down to $200 per mile.

The expenditures per mile in the 12 months on the various classes of pavement, according to Mr. Cotterill's paper, were as follows:

| | Per mile |
|---|---|
| *Brick pavement | $1,453.8[illegible] |
| Concrete pavement | [illegible] |
| Sheet asphalt | [illegible] |
| Asphaltic concrete | [illegible] |
| Bitulithic (Warrenite)† | [illegible] |
| Bituminous macadam | [illegible] |
| Waterbound macadam | [illegible] |
| Gravel surfacing | [illegible] |
| Natural earth, grade | [illegible] |

*Large repair expense [illegible] settlement and other defects in original construction.

†High cost due to 6.11 miles Warrenite north from Seattle ($783.13 per mile); also repairing worked out section, $261.65 per mile; remainder cost, $85.59 per mile.

Mr. Cotterill commented as follows on the maintenance features:

The statement of expenditures segregated by types of pavement or surfacing present an interesting field for comparative study of general features. The first five classifications include what are commonly referred to as hard-surface pavements. For purposes of comparison, it must be recognized that the brick and bitulithic roads tabulated were extensively repaired, being practically reconstructed. Eliminating these, it can be broadly stated that the annual upkeep of approximately 150 miles of primary highways covered with hard surfaces was from $50 to $100 per mile. In sharp contrast, the next three classifications, including the various types of oil- and water-bound macadam, crushed rock and gravel surfacing, covering nearly 1,100 miles, cost from $250 to $350 per mile. Here is a distinct gap of $200 to $250 per mile in annual maintenance cost, between the hard-surface and macadam gravel groups. Furthermore, it is evident that this contrast does not fully measure the gap, because the 150 miles of hard-surface pavement cover highway sections which carry double or triple the traffic that is carried by the other group.

A study of the highways by counties shows that the annual maintenance cost has varied from $75 to $900 per mile, and that this variation is directly proportional to the amount of traffic. It seems safe to conclude that, if the hard-surface pavement mileage had been of the macadam and gravel type, the annual cost for upkeep would have averaged more than $600 per mile. Therefore at least $500 per mile, or the equivalent of 5 per cent interest on a $10,000 investment, is being saved wherever a properly built hard-surface pavement has replaced macadam or gravel on heavy traffic highways.

During the six years preceding 1917 the Washington program of good roads had resulted in about 1,250 miles of construction along the primary state highway routes, of which 330 miles had been improved by the counties under the permanent highway law. The counties had [illegible] on the secondary state routes and at least 350 additional miles from the proceeds of county bond issues. This gave a total of about 2,000 miles of highway, representing an investment of at least $[illegible]

# Reinforced Concrete Track for Testing Motor Trucks

One of the first concrete testing tracks built by a motor truck company has been completed recently by the Diamond T Motor Truck Co. at its Chicago plant. The track was constructed for the primary purpose of trying out trucks being manufactured for the Government. It also will serve for all testing requirements of the company. The track was build adjacent to the factory, being separated from it by reinforced concrete loading platforms.

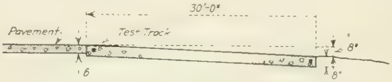


Fig. 1—Section on Curve.

In design the track consists of two straightaways approximately 500 ft. long, each connected by curves at the ends. The shape of the curves is governed more by existing buildings, railway loading tracks and other limitations than from the standpoint of theoretical design. On curves and their approaches where a super-elevation was begun, the track was given a uniform slope without any crown and concrete was made uniformly 8 in. thick; elsewhere it was 6 in. thick at the edges and 8 in. in the center with 2-in. crown. Width was also gradually increased from 20 ft. on the straightaways to 30 ft. on the curves. On the sharp curve 10 in. super-elevation was given by gradually depressing the inside and raising the outside. On the other end of the track it was gradually depressed about 8 in. as here it was necessary that the pavement adjoining be kept as level as possible.

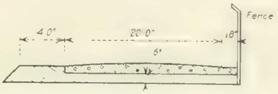


Fig. 2—Section at Middle of Straightaway Showing Shoulder.

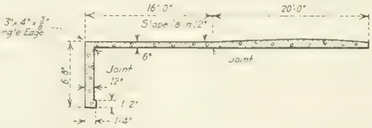


Fig. 3—Section at Middle of Straightaway on East Side, Showing Retaining Wall for Platform and Section of Platform.

Subgrade and drainage were given proper attention. A fill of from 18 in. to 2 ft. was required on most of the area where the track was laid. This fill consisted of slag obtained from nearby industries, foundry sand and cinders. A 12-ton roller was used to compact the subgrade.

Drainage was provided by laying three lines of 6-in. tile with suitable outlets into existing sewers, four inlets being provided aside from the two which drained the pavement near the plant administration building.

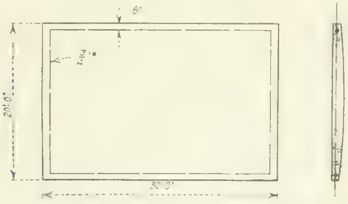


Fig. 4—Slab Reinforcement on Straightaway.

The concrete was proportioned 1:2:3½. Beloit sand and pebbles constituted aggregates. The latter were graded from ¼ to 2 in. Reinforcement consisted of ¾ in. square twisted bars, placed circumferentially around the slabs, which were 30 ft. long. The pavement was finished with belt and roller, a split roller being used at joints to insure continuity of even surface at these points.

# Equipment and Gang Organization for Constructing Concrete Base for Pavements

Labor-saving devices for handling aggregate in the construction of the concrete base for pavements are employed to a considerable extent at Buffalo, N. Y. Two methods which have given good satisfaction were described by Mr. George F. Fisk, assistant engineer, Department of Public Works of Buffalo, in a paper presented at the recent convention of the American Society for Municipal Improvements.

In one of these methods the aggregate is distributed along one side of the street at the rate of 1 cu. yd. for 5½ sq. yd. of surface to be concreted. The material is raised to an elevated bin by a clam shell bucket operated by a crane. From the bin it is discharged through sliding doors into measuring bins and thence by sliding doors over an apron into the mixer hopper. The whole outfit is moved along as the work progresses, the crane leading. The gang with this outfit is as follows:

4 men handling clamshell bucket.
2 men on apron.
1 man operating slide doors.
1 engineer on crane.
2 fine graders ahead.
2 men unloading cement.
1 man wheeling cement.
1 man dumping cement into hopper.
1 man for bucket boom.
4 men grading concrete behind mixer.
1 mixer engineer.
1 fireman.
1 foreman.

This gang of 22 men will lay about 1,200 sq. yd. of 6-in. concrete base per day at a labor cost of about 12 ct per square yard. Each batch (12 cu. ft.) is given 14 revolutions of the drum, which revolves at the rate of 24 revolutions per minute.

In the other method the aggregate is placed along the street in piles about 1,000 ft. apart. When possible these piles are located at every second cross street. The mixer, storage bin, measuring box and crane are set up close to each pile in succession. The concrete is discharged directly from the mixer into 2 batch cars which run over a narrow gauge track on the subgrade to the point of deposit. The cars are hauled by a horse, two cars being moved at a time. The gang under this arrangement is as follows:

2 men on fine grading.
4 men dumping cars and grading concrete.
4 men handling cement.
1 man on mixer acting as engineer and bucket man.
1 man on measuring box.
1 fireman.
1 engineer.
2 boys for driving horses.
1 foreman.

This gang will lay between 500 and 700 sq. yd. per day, depending upon the distance the concrete is hauled, at a labor cost of 13 ct. per square yard.

**Suggests State Tax on Automobiles to Provide Funds for 2,000 Miles of Road.**—In a paper presented at the recent convention of the County Commissioners of Georgia, Mr. W. R. Neal, State Highway Engineer, suggested financing the construction of 2,000 miles of hard surface roads by placing a special tax, averaging $20 on each automobile and truck in the state. He stated that this tax, when bonded, would provide $40,000,000, which should be spent in the next five years. Under the plan proposed, the properly located, graded and drained roadbed would be furnished at the expense of the county, while the surface, estimated to cost about $16,000 per mile, would be paid for by the automobile tax.

**Southern Appalachian Good Roads Association Postpones Convention.**—The convention of this association which was to have been held Nov. 17 to 21 at Asheville, N. C., was postponed on account of the epidemic of influenza. A D. Williams, Charleston, W. Va., is President of the association.

# State Highway Construction in New York in 1917

Only 91.96 miles of new highway was placed under contract in 1917 by the State Highway Commission of New York, according to an advance proof of the report of H. E. Breed, First Deputy Commissioner for the year ending Jan. 1, 1918. The following tabulation shows a comparison of the work of 1916 and 1917.

| | 1916 Miles | 1917 Miles |
|---|---|---|
| Actually completed and accepted during the year | 509.94 | 410.02 |
| New contracts let during year | 626.17 | 91.96 |
| There were officially under contract Dec. 31 | 1,425.7[illegible] | 1,116.[illegible] |
| Physically completed, but not accepted, estimated, Dec. 31 | 530.00 | 509.26 |

The amount of work placed under contract, 91.96 miles, is insignificant in comparison with previous records. More work than this was advertised, but bidders were deterred by general conditions, which intensified obstacles that had already seemed insurmountable; scarcity of labor, lack of supplies, difficulties of transportation, constantly increasing cost of materials and workmen, the inefficiency of such labor as could be obtained and the uncertainty of where the market would go next. Many contractors were unable to get bonds, because some of the surety companies issued a blanket refusal. The year showed many failures for which contracts have had to be canceled.

TABLE I—AVERAGE COSTS OF 16-26 FOOT HIGHWAY.
(Exclusive of engineering and advertising.)

| Year. | W. B. macadam. | Bit. mac. | F. conc. | Brick. |
|---|---|---|---|---|
| 1914 | $11,050 | $13,400 | $13,500 | $25,300 |
| 1915 | 10,000 | 11,000 | 13,400 | 24,200 |
| 1916 | 11,600 | 13,700 | 15,000 | 27,750 |
| 1917 | 12,100 | 14,650 | 18,150 | 29,800 |
| Per cent decrease 1915/1914 | 9.5 | 17.9 | 0.7 | 4.4 |
| Per cent increase 1916/1914 | 5.0 | 2.2 | 11.1 | 9.7 |
| Per cent increase 1916/1915 | 16.0 | 24.5 | 11.9 | 14.7 |
| Per cent increase 1917/1914 | 9.5 | 9.3 | 34.4 | 17.8 |
| Per cent increase 1917/1915 | 21.0 | 33.2 | 35.5 | 23.1 |
| Per cent increase 1917/1916 | 4.3 | 0.7 | 21.0 | 7.3 |

TABLE II—AVERAGE COST OF ITEMS
(Compiled from bid prices.)

| Year. | Exc. | 6" vit. Drain. | C. I. Pipe. | S. con. | Reinf. | Bot. stone. | Conc. found. | F. con. pavt. | Brick pavt. | Bit. mat. "T." |
|---|---|---|---|---|---|---|---|---|---|---|
| 1915 | $0.45 | $0.20 | $33.00 | $7.70 | $0.07 | $3.00 | $5.00 | $6.42 | $1.40 | $0.120 |
| 1916 | 0.52 | 0.21 | 39.00 | 8.08 | 0.07 | 3.33 | 5.45 | 6.99 | 1.55 | 0.125 |
| 1917 | 0.63 | 0.27 | 49.00 | 9.06 | 0.09 | 3.75 | 6.68 | 9.21 | 1.76 | 0.129 |
| Per cent increase 1916/1915 | 15 | 5 | 18 | 5 | 0 | 11 | 9 | 9 | [illegible] | [illegible] |
| Per cent increase 1917/1916 | 21 | 28 | 25 | 12 | 28 | 13 | 20 | 32 | 13 | 3 |
| Per cent increase 1917/1915 | 40 | 35 | 50 | 17 | 28 | 25 | 33 | 43 | 26 | 8 |

After a number of futile advertisements from which no bids were received, it was decided that there was enough work under contract to utilize all the labor that would be available and all the materials that could be procured. The Department also had a large amount of repair work that was more necessary than construction, so it was decided that lettings should stop.

The increasing number of canceled contracts, the inability of some contractors to complete work and the dilatory tactics of others resulted in many roads being torn up and left impassable. Numbers of them were in such shape last year as to cause serious inconvenience and loss to the public. On the most important of these roads, such as a through route connection, the Commission organized contractual forces and did the work itself. Sixteen contracts were taken care of in this way which at contract prices represents $1,140,493. Of the amount of work thus taken over, the Commission did work representing $440,074, completing six contracts while two were in such shape that they were to be completed before July 1, 1918.

In many cases where work was not canceled it was necessary to do a large amount of temporary work to keep the roads in passable condition for use by the public. This was done by the Commission's forces whenever it was impossible to get the contractor to move ahead.

Table I shows the average cost of 16-26-ft. highways and Table II shows a comparative cost of items compiled from bid prices:

# First Year's Operation of Bureau of Street Cleaning of Philadelphia

On May 1, 1917, an ordinance separating the Bureau of Highways and Street Cleaning of Philadelphia and creating the Bureau of Street Cleaning was approved. The new bureau began its work on May 14. Its operations during 1917 are outlined in the annual report of Robert C. Hicks, Chief of the Bureau, from which the following notes are abstracted.

**Inspector's Daily Reports:** One of the first changes made was to modify the form of inspector's daily reports, so that a complete office record would result of the daily physical conditions of the City. This was not accomplished without considerable study, and the resulting reports have proved their worth, and their use will be continued in the year 1918.

**Yardage of Streets Cleaned:**—The figures of the yardage to be cleaned in 1918 are considerably in excess of the figured yardage for 1917. Only a part of this can be accounted for by the increase due to newly paved streets. These figures have been carefully revised and from this result adequate cleaning equipment has been provided, based upon the unit cleaning capacity of each kind of equipment.

| | |
|---|---|
| Average daily yardage cleaned 1917 | [illegible] sq. yd. |
| Average daily yardage to be cleaned 1918 | 11,[illegible] sq. yd. |

**New Ash and Rubbish Equipment:** One new type of equipment and a modification of a type adopted last year were introduced this year; the first, an ash wagon with the Philadelphia sliding steel covers, and the second, the modified Philadelphia type ash truck.

The sliding steel covers are adaptable to any standard type ash wagon or truck. The advantage derived is that in contradistinction to the old canvas covers it is impossible to have more than one-half of the vehicle uncovered at a given time, eliminating to a minimum the dust nuisance while loading. The arrangement of the covers also affords opportunity for loading from both sides simultaneously.

The modified Philadelphia type ash truck is of considerably greater capacity than last year, as the covers have been raised at the center, allowing the addition of about 2 cu. yds. These covers are hinged along the center line of the truck and in the middle of each individual cover.

**Payments for Clean-up Week Work:**—A departure has been made in prescribing the method to be employed in making payment for this work. In the past, payment was based upon loads in excess of a weekly average of loads for the weeks immediately preceding and succeeding Clean-up Week. The practical application of this procedure resulted in disputed claims. In the 1918 contracts the compensation is included in the price bid for collection and disposal of ashes and rubbish for the year 1918.

**Combined Collection Days:**—Departure from the practice of a few years has been made in the collection of ashes and rubbish from separate days to the same day in given districts. None of the advantages of collecting on separate days will be lost, as the refuse will be placed in separate receptacles and removed in separate vehicles, but the great disadvantage of the resultant dirt, due to separate collection days, will be confined to one instead of two days. The amount of salvage from rubbish, which has never been a source of revenue to the City under the separate day collection, is not impaired, due to the continued use of separate receptacles and vehicles. The nuisance, however, of the "scavenger," who in his effort to reclaim any waste of value, disturbs the contents of the container and scatters it on the street, has not been decreased.

**Motor-Driven Versus Horse-Drawn Ash-Collecting Vehicles:**—The unusually severe weather conditions that existed during practically the entire month of December afforded an excellent opportunity for a comparative observation of the relative merits of motor-driven and horse-drawn vehicles for the collection of ashes. The accumulated temperature deficiency for December was 298°, equivalent to a daily deficiency of almost 10°, and the precipitation was practically normal. These combined resulted in very slippery highway pavements. It became apparent at the outset that horse-drawn ash wagons could not be operated at anywhere near their normal capacity, due to this precarious footing, and motor trucks were requisitioned for the service—a few at first, but with the continued severe weather and adverse pavement conditions the number of motor trucks used was increased, and the number of horse-drawn vehicles decreased, until the condition was reached in some of the most seriously affected sections of the City where the motor truck almost entirely supplanted the horse-drawn wagon. One of the features of this situation was that one truck would do the work of several teams, where the hauls to the dumps were long, and all the hauls are getting longer as the City builds up. Still another was that the better paid chauffeurs were willing to face the inclement weather, when the poorer paid horse driver would not come out, resulting in hundreds of the contractors' teams standing in the stables, while these contractors were compelled to hire motor-driven equipment to remove the ashes.

## After the War Highways

There may have been reasons for lack of preparedness for war. There is no excuse for lack of preparedness for peace. Now is the time to lay out extensive systems of highways, secure all necessary rights of way, and meet legal requirements, many of which necessitate months or even years of negotiation. There is ample opportunity for most of this work, but the time will arrive when an emergency exists, and then it will not be practicable to carefully consider all of these details. There will be urgent demand for immediate construction in order to utilize temporarily an excess of labor, such as may result from sudden cessation of war activities. It has been well said that while "thousands who would cheerfully die for their country in the stress of war, would furiously resent going hungry in time of peace," their resentment will be heard in no uncertain terms if we are not ready. It will be to the disgrace of those now in power if "the surviving warriors who were willing to die for their country find themselves unable to procure a living in it."—Prof. F. H. Newell in November Concrete Highway Magazine.

## Quantity of Water for Concrete

In a paper, "The Effect of Time of Mixing on the Strength of Concrete," presented at the last convention of the American Concrete Institute, Prof. Duff A. Abrams of the Structural Materials Research Laboratory of Lewis Institute, Chicago, gives the following suggestion:

The only safe rule to follow with reference to water in concrete is to use the smallest quantity of mixing water which will give a plastic or workable mix, then provide plenty of moisture for the concrete during the period of curing, which follows setting and hardening of the concrete.

**Illinois Votes $60,000,000 Bond Issue for Roads.**—By a majority of nearly 200,000 votes the citizens of Illinois on Nov. 5 authorized a $60,000,000 bond issue for constructing 4,000 miles of highway. Plans for some 500 miles of highway already have been completed by the State Highway Department, and it is hoped to be able to begin construction in the spring on 800 to 1,000 miles of the hard surface road.

## Self-Feeding Bucket Loader Facilitates Handling Crushed Rock on Paving Job

By using a self-feeding bucket loader for rehandling crushed rock, Ryan Brothers, the contractors for paving North Broadway, in Chicago, have been able to considerably reduce the cost of getting the stone for the 6-in. concrete base to the mixer. The stone was dumped in piles along the sub-grade in accordance with the usual practice. Instead, however, of shoveling from the piles into wheelbarrows, the bucket loader was used to elevate the material into a bin attached to the front end of the machine, from which the wheelers obtained their supply. By this plan fewer shovelers are needed and less time is required for filling the wheelbarrows. The loader moves from pile to pile as the concreting progresses.

Self Feeding Bucket Loader Handling Crushed Rock on Paving Contract. Left Hand Insert Shows Feeding Discs. The Bin Is Shown in Other Insert.

Four men are employed at the loader—an engineer, a man at the gate of the storage bin, and two men trimming up around the feeding discs. Four wheelers convey the stone to the mixer. On similar work last spring the gang getting material to the mixer was four or five men larger, yet it handled 15 to 20 per cent less yardage than the present gang.

The loader is equipped with a Novo gas engine, which furnishes the motive and tractive power. The machine was brought to the North Broadway contract from 75th St. and Ashland Ave, a distance of about 17 miles, under its own power. In moving from job to job the machine can make from 4 to 5 miles an hour. The machine has been in operation since June 5 and in that period 4 hours would cover its lost time.

The loader is manufactured by the Barber-Greene Co., of Aurora, Ill. It has been applied to a wide range of loading requirements, but Ryan Bros. were the first to employ it for the particular service described above. To fit it for such work a number of modifications were made. Such of these changes as have been found worth keeping have been incorporated in the present design.

The North Broadway job is an excellent example of the skillful use of labor-saving machinery. The old brick pavement and its macadam base were ripped up with a Marion steam shovel and loaded into 10-ton trucks. The shovel left the sub-grade in such condition that very little hand trimming was required. The concrete is being mixed in a Koehring mixer, equipped with a 20-ft. boom. Labor-saving machinery has made it possible for the contractors to get along with three-fifths of the ordinary gang for such work. It has further enabled them to accomplish with inferior labor all that they did before the war, when it was possible to get all the good men needed.

## Widening Concrete Road By Bituminous Macadam Shoulders

Bituminous macadam shoulders, 3 ft. wide, have been constructed by the Wayne county, Michigan, Road Commissioners on the 18 ft. concrete pavement on Woodward avenue, in order to relieve traffic congestion. This road has been carrying over 10,000 vehicles a day. The methods of constructing these shoulders is described in the recently issued report of the commission.

A trench was dug on each side of the concrete to the subgrade, approximately 7 ins. deep and 3 ft. wide, and limestone, ranging in size from 1 in. to 2½ ins., were placed in this trench, in two courses; the bottom course was thoroughly rolled and water bonded before the top course was added.

The top course, after being leveled and rolled once with a 10-ton roller, was sprayed with Tarvia-X, under steam pressure, at the rate of about 1¾ gal. per square yard. Granite chips were added immediately behind the hot tar. Great care was taken to sweep the edge of the old pavement perfectly clean, so that the stone would adhere to the beveled edge of the concrete.

After this work was done, the shoulders outside of the penetration macadam were trimmed and widened, the ditches regraded and cleaned, catch basins being placed at all low points, to remove surface water as fast as it accumulated.

**Weather Forecasts for Motor Routes.**—The Weather Bureau of the U. S. Department of Agriculture has arranged, in co-operation with the State Highway Commission of Pennsylvania, to aid the automobile and motor-truck traffic during the coming winter over the Lincoln Highway between Pittsburgh and Harrisburgh by giving out daily information of the weather conditions prevailing over the route and issuing weather forecasts and warnings of heavy snows and cold waves for the region traversed. The plan is for the assistant superintendents of highways at points along the route to report to the Weather Bureau office at Pittsburgh at 8 o'clock each morning by telephone or telegraph the depth of snow or ice on the highway, giving its general condition. These reports are published in the newspapers and furnished to the different automobile clubs, thus becoming available to automobile and motor-truck drivers passing over the highway. The forecasts and warnings are given public distribution and telegraphed to the superintendent of highways at Harrisburg, who gives instructions to his forces along the highway to make provisions for the anticipated weather conditions. This service was in operation last winter and gave great satisfaction. The Weather Bureau is ready to give similar service to other traffic routes as may be desired.

**Spring Breakup of Roads in New York State.**—A survey of the breakups in the New York state highways in 1917 showed that if these bad places were laid end to end they would make 48 miles of 16 ft. pavement. This is a decided improvement over the figures of 1916 which showed 82 miles of disintegrated pavement.

## Standard Sizes of Crushed Stone from the Standpoint of the Producer*

By R. W. SCHERER,

[illegible]

The movement to standardize commercial crushed stone sizes, inaugurated by engineers of the Bureau of Public Roads, should be and will be heartily welcomed by crusher operators. Economic plant operation is not the producers' only interest in the matter. They should be and generally are equally interested in the results from the type of construction involved and will be found willing to sacrifice economic operating to a considerable degree to gain better results.

It is difficult to see what a further survey of the screening practice and study of the nomenclature will do to clear up the situation. One could not expect to arrive at a typical set of screens by counting noses, nor by finding a majority of installations that are alike to which the minority would conform. It is also to be regretted that the investigators found it "impossible to record the rate of feeding the stone into the screen." That the nomenclature was in a condition of "confusion worse confounded" needed no demonstration.

**How Product Varies.**—To define a grade of stone all are agreed that size of screen openings through and over which the material passes must be stated. When these are stated the product may still vary from several causes.

First. There is an appreciable difference in the product of round and square perforations. A hole described as 2 in. square will pass a larger stone than a round one 2 in. in diameter. Square perforations are still used, though to a very small extent except in fine screens. It would be safe to confine the question to circular holes; where square perforations are retained they must be made the equivalents of circular openings.

Second. It makes a noticeable difference in the product whether screens are stationary or revolving. On a stationary screen the stone particles slide over the surface; they are held on their longest dimension. In a revolving screen the stones roll and can and do go through holes no larger than their smallest dimension. The difference in size of product is so great that the stationary screen will retain 20 to 40 per cent of material that has been passed through a revolving screen of the same size perforations. This means that the specification still retained by some engineers—naming the largest dimension as the determining one is not practicable, since stationary screens are almost unknown in the industry. If engineers knew this, they might discontinue the practice. They could guard against "slivers" by other means.

Third. It makes a difference, of course, whether a screen of any type is overloaded or not. More often it is the large plant that has inadequate facilities for separating the sizes. Fines are carried over to the next section having larger openings. Thorough screening should be understood in designating sizes and how thorough it should be will be discussed in another paragraph.

**Nomenclature.**—Now, then, to get clearness in the matter of describing sizes. Let us describe a given product at least technically by the size of perforation which it passed through and the size of perforation that held it and let us understand thoroughly that the figures are for a round perforation, for a revolving screen, and for a screen of sufficient capacity for the plant.

And if we can best describe a given product by maximum and minimum smallest dimension, for technical purposes, why not for all purposes? Why should there be the conflicting nomenclature of numbers and more or less descriptive names. In fact, dimensions are the one description that now are universally intelligible, and it would seem that for all practical purposes, ordering stone, specifying, invoicing, and all, it is just as easy to refer to 2-1 in. stone as it is to write or talk about 23 or medium fine stone.

Probably the best established and most universal system of nomenclature is that of the granite crushers both East and West where No. 1 stone is always very nearly 2¼, 1½, and ¼ in. and finer called No. 4. It would be very difficult to accustom the granite trade to another system of numbers, while they could be led to adopt the figures limiting the sizes.

**Limiting the Number of Grades.**—Once we have means of describing grades of crushed stone and it would seem that with the above understanding—2-1 in. stone or any other size would mean the same thing everywhere—a further understanding could be arrived at between the producers on the one hand and road builders, engineers, and architects on the other hand as to grades that should be offered by the former and demanded by the latter.

The advantages to the crusher operators, if the number of grades can be reasonably limited, are manifest. There can be no question that there has been on the part of engineers—less of road engineers than of the specialists in structural concrete—considerable academic dogmatism about sizes for certain purposes—they have been just "finnicky." But—and this is from the quarryman's standpoint as well as the engineer's—results must be considered. It is to the quarryman's interest—and some of them can see it—to furnish just the size that will give the best results. It is incumbent on all parties interested to ascertain how much of this fastidiousness is justified and in how far the results in road or concrete are affected by a slight variation from the size demanded by some engineer whom the quarryman thinks pedantic.

**The Demands of Engineering Practice.**—Here are some thoughts from the standpoint of the quarry operator who is interested in results, which it is hoped may illuminate the subject. On the one hand, some paving engineers, using stone in a special process of asphaltic concrete paving, have insisted on a product passed through a screen ⅛ in. larger or ⅛ in. smaller than was commercially produced. This seems to be pedantry that passes for scientific aggregating. In stone above 1 in., ⅛ in. more or less can make no possible difference; even a ¼-in. variation seems unreasonable in 1-in. and larger stone. The demand for such variations can be eliminated.

On the other hand, quarrymen are at fault when they fail to recognize the imperative necessity for good screening. And here is where they should consider results. Stone for macadam must be distinguished from stone for concrete, and differently prepared. It makes no difference what the hardship on the quarrymen may be, results to a certain extent justify the sacrifice.

The distinction can be simply stated in this way: In macadam stone there must be a large percentage of voids, while in concrete stone the percentage must be as low as possible. To elucidate, no road builder can bind a crusher-run stone. Fines, when present in coarse stone, close the interstices and prevent the entrance of the binder even when that binder is hot tar. How much more must these fines prevent the entrance of stone screenings in water-bound macadam. In penetration macadam, road builders have had to discontinue the practice of dumping loads of the top course stone on the base, because as the load is spread with shovels the "fines" remain on the spot. The stone "mats"; the binder, instead of covering each stone, spatters on the mat; the binder does not anchor in the body of the course, and a bald spot results. A large percentage of failures of "poured macadam" is due to poor screening. Fines should not be tolerated at all. The engineers of the Bureau of Public Roads suggest a maximum of 15 per cent, but 10 per cent should be the limit; 0 per cent should be aimed at.

There is no "finnickyness" about demanding good screening for macadam. Not only should the fines be removed but the range of sizes in any one grade should be restricted as much as possible for macadam stone and as wide as possible for concrete work. Thus, for macadam top course, 2-1½-in. stone is better than 2-1-in. The former being more even sized has more voids, and voids are what is wanted.

**Screening Concrete Aggregates.**—On the other hand, concrete aggregates must have a minimum of voids; the greater the range of sizes the better the results. Stone ranging in size from 2 to 1½ in. has 50 per cent of voids. To make a dense concrete, one-half of the concrete must be mortar, or a mixture of cement and fine aggregates. Well-graded stone ranging in size from 2 to ¼ in., when intimately mixed, has 35 per cent of voids or less, leaving just that percentage to be filled with mortar. The efficiency of the cement in the latter case is increased from 35 to 50, which means over 40 per cent.

The proofs for this are abundant. Whenever and wherever coarse aggregates have been tested for the compressive strength of the resultant concrete the well-graded samples have stood the highest tests. In fact, from the vast number of experimental tests of fine aggregates, in which investigators all over the world have used three sizes designated as fine, medium, and coarse, plotting their results on what is known as the Feret triangle, it is evident that 70 per cent of the largest size permissible, 20 per cent of the medium, and 10 per cent of fine results in the best concrete. Why should not engineers insist that not less than 25 per cent nor more than 50 per cent of, say, a 2-¼-in. concrete aggregate shall pass a 1-inch and why should not quarrymen be prepared to furnish it?

Again, this is not pedantry. Why? A concrete made of all 2-in. stone and an ungraded sand is an absolute failure, it is full of voids and can be worked only with a detrimental excess of water. A great deal of similar concrete has gone into bases of pavements and it is to be wondered at that there are not more failures. This specification would be no hardship on any crushing plant. It is not necessary that the two or three sizes required be mixed in a bin; they can be loaded on the cars or trucks, one over the other and would be mixed in unloading, at least in the case of cars unloaded by shoveling. Mixing in bins is undesirable for another reason; a bin full of mixed sizes does not stay mixed. There is the well known separation by gravity, the large pieces always rolling to the outside of the pile. If the bin is large enough a rather close separation can be obtained by gravity.

**Must Take Concessions.**—These, then, are concessions which quarrymen must take for the sake of results, thorough screening in macadam stone and thorough mixing in concrete stone both within reasonable limits. That state testing engineers and chemists are willing to concede the ridiculous fractional sizes is apparent from their preliminary report. (Department of Agriculture Bulletin No. 55.) They recommend the following screen perforations: 3, 2, 1, ½, and ¼ in. The nomenclature proposed consists of the numbers 3, 2, 1, ½, and 0, corresponding to the largest size contained in the grade. Thus No. 3 stone is 3-2 in. Combinations of the numbers are proposed; thus No. 1, 2, 3 means a mixture of ½, 1, 2, and 3 in. From the fact that this system of designating grades is the very contrary of the only system that has been at all firmly established in any branch of the industry, that of the granite quarries, it does not seem likely that its adoption universally could be successfully urged.

The logical system of describing grades seems the only one which we could hope to see adopted, that of specifying the limiting sizes. In this system stone for macadam base course would become 3-2 in. instead of No. 3 as is proposed, or instead of "ballast," "macadam," "2-in. stone," or "3-in. stone," as is now the confusing practice in different localities. Stone for cement concrete wearing surface would be simply 2-¼-in. instead of No. 12, as is proposed. One-half inch screenings would become "½ in. and finer." There can be no doubt that the nomenclature would be universally intelligible and, with the restrictions mentioned above, would be accurate.

The First Conference of State Testing Engineers and Chemists evidently considered only road work; the requirements of structural concrete must be considered and this will probably add another screen and grade—1½ in. round perforations. This will not be seriously objected to by crusher operators, 2-1½ in. stone for second course macadam will give very much better results than 2-1 in. For concrete 1½-¼ in. material is vastly better, is as easily worked and will be more acceptable even for reenforced work than 1-½ in.

**Standardization Desirable.** The adoption of standard sizes is possible. The action of the Bureau of Public Roads in inaugurating a movement to bring this about is to be highly commended. Their engineers have shown a disposition to meet the producer more than halfway. If, in addition, other interests are considered, possibly the American Society for Testing Materials, the quarryman who has conformed his screening plant to the standards prescribed, would have the highest engineering authority to protect him from the whim or caprice of pedantic road builders and engineers, and other engineers on their part would be assured of getting what they specify. To recapitulate:

1. The establishment of standard sizes of crushed stone adopted throughout the States is possible and highly desirable.

2. To accurately define a grade of stone, screen perforations, through and over which it passed should be given. It should be universally understood that (first) circular perforations are meant, (second) that the screen is a revolving one, and (third) that the screening plant is adequate so that any one grade shall contain not more than 10 per cent of fines (possibly 5 per cent) and not over 5 per cent oversize by laboratory tests and that (fourth) a mixture of various grades such as 2-¼ in. shall contain not less than 25 per cent nor more than 50 per cent of "fines" pasing through a 1-inch screen, that is, through perforations having one-half of the diameter of the maximum sizes permitted in the mixture.

3. The following screen sections are proposed: 3, 2, 1½, 1, ½, ¼ in.

4. The nomenclature should be the logical one, simply stating maximum and minimum sizes.

## Cement Bag Holder on Mixer

A useful device for saving empty cement sacks is employed by Ryan Bros., paving contractors, of Chicago. Attached to the frame of the mixer near the loading hopper are four pieces of iron which form a holder, as shown in the illustration. The cement handler, as soon as he has dumped the cement in the hopper piles the sack in the holder. When 50 sacks have been piled they are tied in a bundle and laid to one side. This arrangement not only does away with the loss of the sacks, but it also makes it easier for the inspector to keep track of the amount of cement used.

Device for Saving Empty Cement Sacks.

## The Engineer in Road Work*

BY RODMAN WILEY

[illegible]

It is pertinent at this time that you should better understand the aims of the engineers engaged in road work. Some of you might think that on occasions they are arbitrary, dictatorial and altogether undesirable persons, who try to say to the various fiscal courts what they should and should not do, but such is not the case. They are laboring for your interests; they are anxious to see every administration a success regardless of what political power may be in control; they are your servants, not your masters, and they realize that in its final analysis the people are their clients.

In the financial end, engineers are oftentimes called upon to make an examination of the road needs of a community, the possible resources, and to report to the constituted authorities the amount of money needed and the best method of securing it; at other times they advise with the proper authorities to see if their program is sound from a financial standpoint, just the same as engineers are called upon to report to bankers and brokers on the soundness of investments in other lines of work. Today very few investments of any size are made unless the proposition has the approval of some well known engineer in whom the investors have implicit confidence.

Everyone has seen on numerous occasions the mistakes that have been made by viewers in locating roads. It must be remembered that wherever a road is built school houses, residences, churches and business houses will follow the development. In case the location is bad, it is most difficult and oftentimes impossible to provide any remedy, because if the location is changed all the improvements are lost, consequently the taxpayers are compelled from year to year to pay a heavy cost for maintaining an improperly located road. On the other hand, very few of you have ever seen a road located by good engineers that ever needed to be changed. France, Belgium, England and Italy realized centuries ago that whenever any road improvement was started it should be in charge of the most competent engineers in the nation, consequently the roads in these countries have been located with such foresight, such knowledge of the development of the country that it is almost impossible even at this time with all our advanced ideas and new methods of travel to make any desirable changes.

The great trouble has been principally the fault of the taxpayers. They have not called for a business-like administration of the road affairs of their counties and consequently they have not received it. A road is simply one of the systems of transportation and its location requires as much if not more skill on the part of an engineer as the location of a railroad, because a railroad company usually has ruling grades, ruling degrees of curvature and no departure is allowed from those standards, whereas when locating a road an engineer must have a vision. In his mind's eye he must see the country as it will grow and as it will be years after the road is built. Consideration must be given to the finances of the county which is usually not the case in railroad work. A railroad company might expend thousands of dollars to reduce a grade ½ per cent, to reduce the degree of a curve one or two points, but in road work an engineer adopts such grades as will insure the economical construction of the highway, provided, of course, that traffic will not be impeded. Highway location calls for rare judgment on the part of an engineer.

The grading of a road requires the same amount of skill and experience on the part of the man doing the work as does the grading of any railroad or interurban line. The same kind of machinery, the same instruments are used for both classes of work. A railroad company never considers for one moment starting any construction work without having experienced engineers on the ground at all times to see that it is properly done; a contractor doing the work knows from bitter experience that he cannot hope to make money unless he has an experienced man in charge, and I cannot understand how men entrusted to build roads can figure that they can depart from the usual custom or that they can break all precedents and do something that railroad companies and contractors have found to be impossible from an economical standpoint and impracticable from all other angles.

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*Abstract of a paper presented at the annual meeting of the Kentucky Highway Engineers Association.

When it comes to surfacing any road, the man in charge should have a thorough knowledge of the behavior of all local materials under different kinds of traffic and different climatic conditions, as well as to understand the method of doing the work. Experience has shown that attention to minute details is necessary if any type of road is properly built. All of you have seen roads built of stone and you know that one man can take a certain amount of stone and build a good road and another man will take the same class of stone and the same amount of stone and build an inferior road. That shows for itself that there is something in a man knowing how. However, the most important thing about the surfacing of any road is knowing the type to select. A great many man have had sufficient experience to know how to build a gravel road, a macadam road or most any type of road that might be selected, but the real engineering comes when we are trying to decide the proper type to build in certain localities. To intelligently make a decision, consideration must be given to the finances of the district, availability of materials, local materials, the kind and volume of traffic passing over the road, possible increase in traffic due to the improvement and the approximate cost of maintaining any type that is decided upon. Hundreds of millions of dollars have been wasted in this country by building the wrong type of road. In this state in the central section, we find almost invariably macadam roads, in western Kentucky gravel roads, and in most instances those types have been built without any consideration whatever being given to the traffic that has or will pass over the road during its life. To my mind, the selection of the proper type of road requires the highest type of engineering ability and before building any road it would be economical and certainly good common sense to get the advice of the foremost engineers in the country as to the most economical type.

On many of the roads in this state even at this advanced age we find that it is impossible to transport the ordinary road machinery because the drainage structures will not carry the loads. Sometimes you see fairly good roads on which there has been installed drainage structures totally unsuited to the traffic. We also find that structures of the wrong size have been built: it is not uncommon to see a 100-ft. span trestle where perhaps a 4x4 culvert would suffice. Oftentimes we see a culvert pipe installed which is totally incapable of carrying the water and even the determination of the proper size of any drainage structure is a high class engineering problem. Everyone should know by this time that the design of culverts and bridges is a branch of engineering that requires years of training and experience.

No railroad company would consider for a moment letting one of their section foremen build a bridge or culvert according to his own ideas; on the contrary, every structure is carefully designed, carefully checked several times before it is ever allowed to be installed. The great trouble with highway work has been that most everyone thinks they understand how to design and build drainage structures and we find today our highways adorned with structures which have little to commend them except the enormous prices paid by an unknowing public.

After a road is built it must be maintained and everyone who has had any experience in road maintenance knows it should not be attempted by any but experienced men because it is one of the easiest ways known to waste money. Just what to do to a road in certain stages of deterioration is one of the most difficult things for even the most experienced engineers to determine.

I have seen some men use 500 cu. yd. of stone to the mile and make less showing and do less good than an experienced man would with 100 yd. of the same material.

It has always occurred to me as being peculiar that separate accounts have not been kept showing the expenditures which have been made on a road; today it would be impossible to go to any county in this state and find the cost of a single mile of road unless that mile had been built under state supervision where cost records are accurately kept. It is part of the training of an engineer to analyze costs, to aggregate costs so that they know not only the original cost of any improvement, but also what it has cost from year to year; only by keeping and knowing such things can we ever be certain that we are doing economical work.

I have endeavored to show you that every phase of road building is an engineering problem and the sooner that fact is realized the sooner will the taxpayers be properly protected. But the thing I am contending for will not come over night. Men without any knowledge of the subject will be elected to office on some fake issue and will continue to build roads according to their own pet theories, many of which will be at variance with good engineering, but the taxpayers should remember that they are paying for all mistakes made.

Noted men have made the statement that of the $300,000,000 expended in this country on roads last year that at least one-third was wasted, and it is now time for the people to take this matter in hand and see that not a single piece of road work is attempted unless done by skilled engineers; then every cent expended on location will be a permanent investment, every fill and every cut that is made will be properly done, every bridge and every culvert built so that it will carry the loads that pass over the road. The type of surfacing used will be the most economical one, and the roads when once built will be maintained instead of being allowed to deteriorate from day to day. Every cent expended will be properly accounted for, and then and only then will the taxpayers realize a dollar's worth of work for every dollar of their money invested in roads; when such time shall come the people will be willing to pay taxes for roads, because they will see that their interests are properly safeguarded, and we will have more and better roads at a cheaper price.

## Wayne County Experiment in Resurfacing Old Concrete Road with 3 In. of Concrete

In June, 1916, the Road Commissioners of Wayne county, Michigan, widened out a section of old concrete road from 16 ft. to 20 ft. and resurfaced it with 3 in. of reinforced concrete. The methods employed in this experiment were described in the March 7, 1917, issue of Engineering and Contracting and a progress report on the condition of the road appeared in the Dec. 5, 1917 issue. The following statement regarding this work is reprinted from the report of the commission for the year ending Sept. 30, 1918:

"This resurfacing job has gone through two severe winters and at all times carries an exceedingly heavy traffic, both in numbers of vehicles and tonnage. At the present time it is in practically the same condition as when it was opened for traffic, over two years ago. Where the road was widened 2½ feet, there are no cracks at all, nor any suggestion of demarcation. We consider this experiment an unqualified success in every particular."

## "Mushroom Top" Expansion Joint

A new pre-formed filler for pavement joints has been placed in production by the Standard Asphalt & Refining Co. The joint proper consists of a core of tough, tenacious asphalt reinforced with two bands of flexible felt. The novelty of the design consists in the termination of the felt reinforcing a short distance below the top of the joint, leaving a narrow section of the asphalt core entirely exposed. The advantage claimed for this construction are as follows:

First—Actual contact is obtained between the pliable "Mushroomed" asphalt core and the sidewalls of the joint. Second—The "Mushroom" is expanded in the joint space by the weight and impact of traffic forming a permanently watertight contact between the pliable "Mushroom" core and the joint walls. Third—As installed about ¼ in. of the "Mushroom" should project above the joint. This projection is gradually reduced by being wedged tightly into the joint by traffic. The surplus is gradually spread over the edges, forming a tough, permanent armor, which protects the corners against damage by traffic.

## Snow Removal Program of Highways Transport Committee

A definite program having to do with the solving of the snow removal problem as it may affect adequate highways transport during the coming winter has been formulated by the Highways Transport Committee of the Council of National Defense and is now being sent out.

This program is based upon the realization that if the post war period of reconstruction, which includes as a vital part the movement of food stuffs and other commodities over the highways, is to be made equal to the needs of the situation every character of obstruction to such transportation must be anticipated and guarded against.

The snow removal problem, probably the most vital from the standpoint of the efficient and continuous flow of commodities along the highways, will be given intensive study by the Highways Transport Committees of the state directly affected.

To that end requests have been issued to the organizations in Massachusetts, Maine, Vermont, New Hampshire, Rhode Island, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, West Virginia, Ohio, Indiana, Kentucky, Michigan, Illinois, Wisconsin, Minnesota, Iowa, Missouri, Kansas, Nebraska, South Dakota, North Dakota, Colorado, Wyoming, Montana, Idaho, Washington, Oregon, California and Nevada, that they give immediate attention to the following general subjects outlined by Mr. Raymond Beck, field engineer, relating thereto:

First—Of the powers of the State Highway Department or Commission for removing snow. If such powers are not specifically covered by statutes, whether maintenance funds can be used in an emergency?

Second—What co-operation and work can and will be undertaken by the counties and state?

Third—What co-operation and work can and will be undertaken by the municipalities and state?

Fourth—What snow removal machinery, such as scrapers, plows, etc., are available for use by state, county and municipalities?

Fifth—What preliminary measures can be undertaken which will prevent the drifting of snow, such as location and erection of snow fences. Also, the change of rail, board, picket and hedge fences which check the currents of air during a snow storm, thus causing drifts to form, and removal of brush or weeds paralleling the road, which invariably causes drifts to form.

Sixth—Attention by State Highway Department or Commission, through its field organization and in co-operation with the State Highways Transportation Committee, of physical conditions along the highways tending to cause drifts. Recommendations as to the best means of dealing with same by preventive methods.

Seventh—The making of snow removal report of every snow storm on such highways as are designated to be kept free from obstruction by snow so as to allow continuous essential highways tranportation.

## War Service and Reconstruction Committee of Highway Industries

The Highway Industries Association, which is calling together, with the co-operation of the American Association of State Highway Officials, one of the greatest convention ever held, at the Congress Hotel, Chicago, Ill., Dec. 11th and 12th, announces that a War Service and Reconstruction Committee of the Highway Industries has been formed with the co-operation of the Chamber of Commerce of the United States.

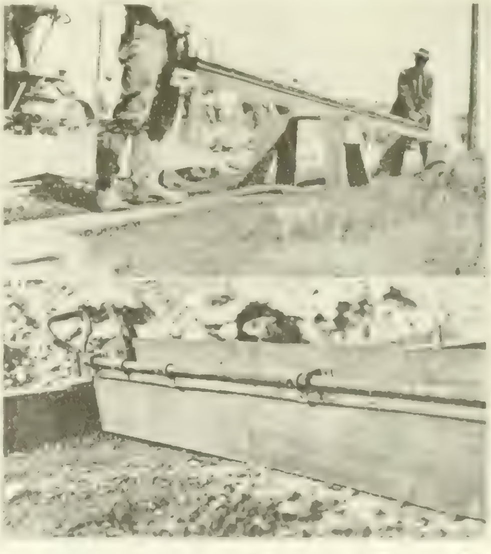
This new War Service and Reconstruction Committee is taking part in the general conference of War Service and Reconstruction Committees of American Industry, which is being held at Atlantic City, N. J., Dec. 3-6. In its announcement of the appointment of the committee the association states:

Official Washington has for many years closed both eyes and ears to the public highway and today its importance is ignored and buried in one of the branches of our government from which it must be rescued if our country is to retain its place among the other civilized nations. The neglect in allowing our highways to lose their proper place in our general system of transportation is today penalizing the country many times the cost of highway improvement.

The economic values of improved highways were ignored by the federal government in its plans for winning the war. We have been pleading with the farmer for greater production and efficiency on the farm and the farmer is responding through improved methods and equipment, but what are we doing to aid the farmer in marketing his product? Last year and again this year we will lose millions and millions in food products and farm labor because of inability to market the products when they should be marketed. We are crying food conservation and the public is responding nobly, but our waste through our indifference to the country's needs in improved highways is many times greater than our saving. Mr. Hoover, Federal Food Commissioner, states that 50 per cent of our perishables grown are wasted through inability to market, due to bad roads. He has also warned the people of the United States that the food shortage after the war will be more acute than during the war.

## Expansion Joint Installer for Concrete Pavements

An expansive joint installer, that has proved very serviceable on concrete road construction for the Utah Road Commission is shown in the accompanying illustration. The device consists of a 6 in. wide steel plate, stiffened by a 3x3x¼ in. angle and braces riveted from the lower leg of the angle to the middle of the unsupported portion of the steel plate. The double ply joint filler is held by a clamping-bar against the smooth side of the plate. The Utah standard section for concrete pavement is 8 in. thick at the center and 6 in. thick at the sides. The stiffener angle accordingly is offset downward 2 in. so that it will rest on the 6 in. channel forms at the edges of the pavement. In making a joint the surface of the steel plate is held in a vertical plane by three or four steel pins driven into the subgrade at the sides of the installer. It has been found that no difficulty is experienced in removing the steel plate if it has been promptly cleaned after the previous removal. We are indebted to Mr. Ira R. Browning, engineer State Roads Commission, for the photographs and the above information.



Expansion Joint Installer Devised for Use in Concrete Road Construction in Utah

## The Chicago Highway Congress

Owing to an important meeting of the War Service Committees of the United States Chamber of Commerce the conventions of the American Association of State Highway Officials and the Highway Industries Association originally set for the first week of December have been postponed to Dec. 9 to 13. The joint meeting of the two associations will be held Dec. 11 and 12. Every citizen of the United States who is interested in public welfare, to the extent of protecting the investment already made in highways and to see their future development along definite, aggressive and sensible lines should be present and personally participate in the deliberations of this joint meeting. The sessions will be held in the Congress Hotel, Chicago. The program for the two days includes the following:

**Wednesday, Dec. 11.**

Address of Welcome—Hon. Frank Lowden, Governor of Illinois. Response to Address of Welcome—Edwin S. Duffey, New York, for the American Association of State Highway Officials; S. M. Williams, of Ohio, for the Highway Industries Association.

Topic: "Highway Control by Federal Government Under War Conditions"—Logan Waller Page, Chairman United States Highways Council.

Topic: "The Development of Motor Parcel Post Routes"—Hon. James I. Blakslee, Fourth Assistant Postmaster General.

Topic: "Highways—A Neglected War-Time Necessity"—Hon. James M. Cox, Governor of Ohio.

Topic: "A Suggested National Highway Policy and Plan"—E. J. Mehren, Editor Engineering News-Record.

Topic: "Highway Transportation, Present and Future"—Roy D. Chapin, Chairman National Highways Transport Committee.

"Highways a Military Necessity."

"The Nation's Needs for Highway Development."

**Thursday, Dec. 12.**

Topic: "The Underlying Principles of Laying Out, Marking and Maintaining a State Trunk Highway System"—A. R. Hirst, of Wisconsin.

Discussion, led by Paul D. Sargent, of Maine, and J. W. Bliss, of North Dakota.

Topic: "Proper License Fees for Motor Vehicles and Drivers"—H. Eltinge Breed, of New York.

Discussion, led by A. C. Batchelder, of the American Automobile Association; A. B. Fletcher, of California, and Duncan Buic, of Louisiana.

Topic: "Motor Trucks and Trailers Transportation Essentials—Regulation of Speed, Weight, Width and Height Necessary, But Should Not Restrict Their Expanding Use"—George M. Graham, Chairman Motor Truck Committee, National Automobile Chamber of Commerce.

Discussion, led by Charles J. Bennett, State Highway Commissioner of Connecticut; A. D. Williams, of West Virginia; Frank H. Zouck, of Maryland; A. W. Graham, of Missouri, and T. R. Dahl, of Ohio.

Topic: "American Highways for Tomorrow"—H. G. Shirley, Secretary Highway Industries Association.

Discussion, led by P. St. J. Wilson, Chief Engineer of the U. S. Office of Public Roads and Rural Engineering, and George E. Johnson, of Nebraska.

**List Prices of Trucks.**—The following figures from the Commercial Vehicle give an idea of the 1919 average list prices for trucks:

| Tons. | |
|---|---|
| Less than ½ | $ 835.00 |
| ½ | 934.16 |
| ¾ | 1,390.93 |
| 1 | 1,815.08 |
| 1½ | 2,224.60 |
| 2 | 2,758.33 |
| 2½ | 2,950.40 |
| 3 | 3,688.84 |
| 3½ | 3,904.82 |
| 4 | 4,177.77 |
| 5 and 5½ | 4,848.72 |
| 6 and 6½ | 5,237.50 |
| 7 and over | 5,600.00 |

**National Grange Favors Market and Post Road.**—The National Grange at its annual convention at Syracuse, N. Y., on Nov. 22 adopted a resolution recommending that the Government should center its highway activities in the building of market and post roads "instead of spending money on boulevards used by few."

## Should Go Ahead With Road Building

The following communication was sent Nov. 25 to State Highway Departments by L. W. Page, Director U. S. Bureau of Public Roads:

In view of the fact that restrictions on highway work have been removed by the action of the War Industries Board, the Fuel Administration, the Railroad Administration, and the United States Highways Council, a great revival in road building should result. In my judgment, no more effective means of insuring employment, particularly to unskilled labor, in the transition period from war to peace can be devised than the vigorous prosecution of all public improvement work. I believe it would be better to go ahead with road work wherever it is needed rather than to wait for a period of lower prices. The benefits of improved highways are immediate, to say nothing of the great desirability of having all labor employes and money active.

Federal aid funds already available, and those which will be made available July 1, 1919, will aggregate $50,000,000, of which amount not over $5,000,000 has been expended. It is quite probable, therefore, that State and Federal funds for construction purposes will, during 1918, run well over $100,000,000. This should constitute a material factor in carrying on the vigorous year's work.

Every assistance which the Bureau of Public Roads can render will be available to the States in dealing with the various problems which may arise.

## Personals

**Elmer E. Sommers** has been appointed a member of the Colorado State Highway Commission for District 1, succeeding Lafayette Hughes, resigned.

**John F. Laboon** has been made a member of the firm of Chester & Fleming, Engineers, Union Bank Bldg., Pittsburgh. Mr. Laboon was formerly in the employ of Chester & Fleming, but lately has been with the Pittsburgh Filter Manufacturing Co.

**Lt. Col. William D. Uhler** has returned to his duties as chief engineer of the State Highway Department of Pennsylvania. During the war Col. Uhler was a member of the United States Highways Council, representing the War Department, and had charge of motor transportation of the department.

## Obituaries

**Adam Sauer,** a contractor of Fort Wayne, Ind., died Nov. 23, aged 59.

**Joe B. White,** for many years County Surveyor at Pine Bluff, Ark., died Nov. 25, aged 57.

**Lieut. Hebert C. Peterson,** U. S. Engineers, died recently in France of Pneumonia. Lieut. Peterson was a graduate of the University of Illinois and was engaged in road construction near Chicago for the state highway commission when war was declared.

**Elmer Washburn,** engineer and banker, of Chicago, died Nov. 26, aged 84. At one time he was a member of the firm of Washburn, Shaler & Washburn, contracting engineers, and constructed the Ticitus and Carmel dams of the Croton Aqueduct of New York, the Marlboro reservoir of the Metropolitan Water System of Boston, and Third Ave. cable railway in New York. In 1891 he was a candidate for mayor of Chicago. For many years he was president of the National Live Stock Bank, Chicago.

## Industrial Notes

**The Chicago Pneumatic Tool Co.,** Chicago, announces the appointment of L. C. Sprague as Assistant Secretary of the Company with headquarters at 52 Vanderbilt Ave., New York City.

**The Associated Metal Lath Manufacturers,** Zenas W. Carter, Commissioner, have removed their general offices from 901 Swetland Bldg., Cleveland, O., to Rooms 813-15, Woodward Bldg., Washington, D. C.

**The C. F. Pease Co.,** manufacturers of automatic blueprint machinery and drafting-room supplies, has removed its city sales offices from 166 West Adams St., Chicago, to its general offices and factory at 213 Institute Place.

**Lee T. Ward Co.,** contractors equipment, Philadelphia, Pa., has moved its offices from the Commercial Trust Bldg., Philadelphia, to 617-619 Filbert St., where it will occupy the ground floor and have a display room and offices.

**I. H. Mills,** who has been associated with the Westinghouse Electric & Manufacturing Co., of East Pittsburgh, Pa., for the past 23 years, has resigned to become superintendent of the Sperry Gyroscope Co. of Brooklyn, N. Y. Mr. Mills began his career with the Westinghouse as a machine operator, and finally became superintendent of the small industrial motor department.

**The Walter A. Zelnicker Supply Co.,** St. Louis, announces the appointment of Joseph Meyerson as Secretary to the President. Mr. Meyerson was associated for 10 years with the Southwestern Tariff Bureau, latterly as secretary to F. A. Leland. Mr. Kottsieper has recently joined the traveling force of Walter A. Zelnicker Supply Co. and will make Southwestern territory. For many years Mr. Kottsieper traveled for the St. Loius Screw Co., prior to which time he was connected with the E. H. Linley Supply Co., and Western Iron & Supply Co.

*Waterworks and Hydraulics Monthly Issue*

# ENGINEERING AND CONTRACTING

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The *articles* in the first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering and contracting field. The *articles* in the first and last issues of each month (1st and 4th Wednesdays) completely cover county engineering and highway engineering and contracting. The *articles* in the third and last issues of each month (3rd and 4th Wednesdays) completely cover steam and electric railway location, design and construction. See the "mast head" on the first page of the Weekly News Section for information about our weekly contract news.

**Roads and Streets—1st Wednesday**
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies

**Waterworks and Hydraulics—2nd Wednesday**
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power

**Railways and Govt. Works—3rd Wednesday**
(a) Excavation and Dredging (c) Harbors and Docks
(b) Rivers and Canals (d) Railway Construction

**Buildings and Structures—4th Wednesday**
(a) Buildings (c) Ship Construction
(b) Bridges (d) Miscellaneous Structures

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## E. & C. Index Furnished Only on Request

Heretofore it has been customary to send the index of our articles to every subscriber. In order to conserve paper the index for the six months ending Dec. 31 will be sent only to subscribers who send a postal card or letter requesting a copy of the index. It will assist us if those desiring the index will notify us at once.

## For Seventeen Years Chicago Has Ignored Important Recommendations of Its City Engineer

John Ericson, City Engineer of Chicago, for 17 years has been urging the metering of all water consumers in Chicago; but the City Councils have been obdurate in refusing to adopt his recommendations. During those 17 years the per capita consumption of water has risen 50 per cent until now it is almost 250 gal. per capita per diem, or more than double what it should be.

[illegible] ago the Chicago Bureau of Public Efficiency undertook a special investigation of the water supply situation and made an elaborate report showing the economic necessity of metering all consumers. Abstracts of that report have been published in these columns so that it is unnecessary to review the conclusions again, further than to say that the report completely upheld Mr. Ericson in his struggle to secure authority to meter all consumers.

More than a year ago Engineering and Contracting began urging the engineering societies and engineers in Chicago to lend their support to Mr. Ericson and to secure the co-operation of the Chamber of Commerce in a publicity campaign for universal metering. The American Association of Engineers has recently come out in favor of metering, and it is to be hoped that other engineering societies will join in the campaign.

On July 22 the City Council rejected a metering ordinance by a vote of 39 to 27, but it is a hopeful sign that 40 per cent of the council favored metering. It was stated by several councilmen who voted against metering that they personally favored it, but that they could not act contrary to the wishes of their constituents.

It is almost incredible that the majority of people in Chicago would reject the advice of John Ericson, a man who has held the position of City Engineer for more than 20 years; and we believe they would not reject his advice if they could and would study his reports and listen to his arguments. But the public can scarcely be expected to study such reports. In fact our representative form of government was devised for the very purpose of relieving the voters of the necessity of passing upon details. Those city councilmen who refused to vote for meters, even though they personally believed in metering, were actually not representing their constituents in a democratic manner. They had been elected neither because they favored metering nor because they opposed it, but because it was believed that they would act in the best interests of Chicago. Now it is clear that what will be for the best interest of the city is not usually to be determined by impressions and snapshot judgment, such as the public is apt to give, but by careful study of every phase of the problem.

John Ericson is, without question, the best qualified of all city officials to secure the data and render a report on the economics of metering. The City Council, acting like a board of directors of a railway, should receive and study the report of the Engineer, and follow his advice unless there are evident errors in the report or powerful economic reasons for not doing so. This should be done even when the public may not at first approve the action of the City Council, for it may safely be reasoned that whatever is done in the interest of the public will soon be seen in its proper light by the public.

We do not doubt that every daily newspaper in Chicago can be persuaded to support the City Engineer and City Council if universal metering is ordered. To secure the support of the newspapers, it might be advisable to ask each paper to have one of its editors meet Mr. Ericson and a committee of Chicago engineers selected by the engineering societies, to discuss the subject of universal metering. Reports are often effective in conveying ideas, but, after all, nothing is so effective as the spoken word. When men meet to discuss a problem across a table, misconceptions and prejudices are apt to be removed by questions and answers. Whereas facts and arguments in cold type often elicit only a silent criticism that remains unanswered because it is silent.

Engineering societies frequently pass resolutions relative to some public matter, and then do nothing more. The passing of resolutions is good as far as it goes, but it should be only a first step. Let it always be followed by action, and particularly by word of mouth appeals to public officials, to other organizations, and to the editors of daily papers. Let committees of engineers go to the representatives and servants of the public. Let them go to chambers of commerce, Rotary clubs, municipal leagues, etc. Let them go to the editors of papers. If such action is taken by the engineers of Chicago, we feel sure that Mr. Ericson's 17 years of effort to save the city millions of dollars will soon result in the adoption of his plan for universal metering. Mr. Ericson has shown not only persistence but courage in his long fight against public opinion. It has even been suggested that he resign so that an unbiased investigation of the metering problem might be made!

We admit that Mr. Ericson has been biased, biased by his knowledge of facts whereas his opponents have been biased because they lacked such knowledge. He has stood manfully at his guns, although risking his position in doing so. Let it be said to the credit of Chicago that he has not been forced out of office. Should not that fact alone serve to encourage any councilman to act upon his best judgment regardless of an opposing public opinon?

The public admires courage and rarely punishes a public servant who shows it. John Ericson has told the public year after year that their waste of water was an unpardonable extravagance, and has done his best to make them stop it. We believe the public is almost ready to act upon his advice.

## Suggested Units for Comparing Water Consumption in Different Cities

For comparing the consumption of water in different cities there should be stated not only the average daily number of gallons per capita, but also the number of consumers in each of the three major classes, namely, (1) domestic, (2) commercial and (3) industrial. In addition information should be given to indicate the aggregate size of the factories in the city, and their general character. Before outlining some of the facts that should be given in annual reports of meter departments, let us look at the water consumption statistics of two New England cities.

During 1917 New Britain, Conn., a city of 55,000, sold to metered consumers a total of 73 gal. per capita per day, of which 57 per cent (or 43 gal. per capita) was used by the factories, the remaining 43 per cent (or 30 gal. per capita) being used by domestic and business consumers.

During 1917 Springfield, Mass., a city of 109,000 persons, pumped 109 gal. per capita, of which 74 per cent (or 81 gal. per capita per day) was recorded by consumers' meters; the balance, 26 per cent, was lost and used for unmetered public purposes. Only 23 per cent of the municipal services were metered, and they used about 4 gal. per capita per day. The metered water was distributed as follows:

| | Per cent |
|---|---|
| Domestic uses | 36.63 |
| Commercial uses | 9.62 |
| Industrial uses | 18.51 |
| Institutional uses | 1.85 |
| Builders' uses | 0.05 |
| Charitable uses | 0.33 |
| Public uses (only 23 per cent of municipal services metered) | 4.96 |
| Outside of Springfield | 2.10 |
| Total per cent | 74.05 |

Multiply each of these percentages by 109 to get the number of gallons of metered water per capita per day; bearing in mind that 26 per cent of the 109 gal., or 28 gal. per capita per day, was not metered, although 98 per cent of all the 15,180 active taps were metered.

It will be seen that the domestic consumers used about 40 gal. and the commercial (or business) consumers used about 10 gal. per capita per day, making a total of 50 gal., for those two classes, as compared with 30 in New Britain. Industrial users (factories, etc.), consumed about 20 gal. per capita per day, which is less than half the per capita consumption by factories in New Britain.

There are, in most cities, only four important classes of water users: (1) Domestic, (2) Commercial or business, (3) Industrial or factory, and (4) Municipal. Had all the municipal taps in Springfield been metered, instead of only 23 per cent, it is probable that the municipal consumption would have totaled 16 gal. per capita per day. In that event the following would be the approximate consumption of water in gallons per capita per day:

| | |
|---|---|
| Domestic | 39.9 |
| Commercial | 10.5 |
| Industrial | 20.2 |
| Institutional | 2.0 |
| Municipal | 16.0 |
| Builders and charities | 0.4 |
| Outside the city | 2.3 |
| Unmetered and lost | 17.7 |
| Total gal. per cap. per day | 109.0 |

For the purpose of comparing the consumption of water in different cities, a segregation of the consumers into the four classes above named and a statement of the daily per capita loss of water is to be recommended. Very little is ordinarily gained by any further subdivision of consumers.

The numbers of each of the four classes of consumers should be stated in every report. This is now rarely done, yet it is clear that unless some idea is given as to the number of each class, comparisons of per capita water consumption may be misleading. Furthermore, each report should give data not only as to the number of factories but as to their aggregate size. Thus it might be stated that the factories have a weekly payroll of so and so many dollars. The local Chamber of Commerce can usually furnish such data.

With increased appreciation of the necessity of flushing streets in order to remove germs that cause diseases of the throat, nose and lungs, we must expect a larger consumption of water for municipal purposes. Also the growing use of water for garden irrigation will increase domestic consumption. Hence it will eventually be desirable to indicate in annual reports the extent of street flushing and of garden irrigation.

To sum up, reports of water departments should give sufficient information about each of the four large classes of consumers to enable the water works managers and engineers of other cities to form a definite idea as to the size and character of each of the four classes of consumers. Where the consumers are nearly all metered, the quantity of water "lost" should also be stated, not only in gallons per capita per day, but in gallons per day per mile of mains.

Were such facts stated in many reports, it would probably be discovered that new units of water consumption could be derived that would be preferable to the present daily gallons per capita unit. Thus it might be found that each domestic consumer would average 300 gal. per day; each commercial or business consumer 600 gal. per day; each $1,000 of weekly payroll of factories, 10,000 gal. per day; each mile of city streets, 6,000 gal. per day for public uses; each mile of water mains, 5,000 gal. lost by leakage. The five units just named are obviously not perfectly ideal, but we believe that some such simple classification into 4 to 6 units would serve most purposes, and would certainly be preferable to the "per capita" or the "per tap" unit.

## Why It Devolves Upon Engineers to Advise Congress on Public Works Programs

In his recent address to Congress President Wilson urges Congress to make appropriations for the reclamation of arid, swampy and logged-off lands, but he makes no other definite suggestion as to public works projects. In fact, he seems to think that nearly all skilled workers will speedily find employment. The return to a peace footing, he says, "promises to outrun any inquiry that may be instituted and any aid that may be offered." He even goes so far as to say of the readjustment process: "It will not be easy to direct it any better than it will direct itself. The American business man is of quick initiative."

There are many business men who are talking in no such confident strain about the celerity with which nearly one-fourth our workers will find new employment when war industries are shut down and the army demobilized. "The American businessman is of quick initiative," but no amount of such quickness will enable him to effect a rapid readjustment where 10,000,000 workers are involved. As well expect the speedy moving of a mountain.

President Wilson, absorbed in his plans for the peace conference, apparently fails to realize the gravity of the industrial situation that confronts America. It will devolve upon professional and business men to arouse Congress to the urgency of planning public works expenditures on a scale commensurate with the needs of the hour. In this movement the 55,000 members of engineering societies should take the leading part. Not only are engineers the only large body of trained economists in the land, but they are particularly well informed on public works matters. From engineers, therefore, should come both legislative programs and specific plans for the wisest expenditures of public funds during the readjustment period now at hand.

## Prof. Mann Advocates Teaching "The Appraisement of Values and Costs"

Thirteen years ago next month this periodical began its career as "a serial sequel to the Handbook of Cost Data." At that time no engineering periodical gave more than a moiety of attention to articles on costs and values. The effect of our long editorial campaign favoring the publication of analyzed cost data may be judged not only by the fact that many other engineering periodicals have followed our lead, but also by the fact that many engineering colleges are teaching cost analysis and cost estimating.

Perhaps the most important report on engineering education ever published is that by Prof. Charles R. Mann, an abstract from the preface of which appears in another column. In that report Prof. Mann repeatedly emphasizes the necessity of teaching "the appraisement of values and costs." For example, he says:

"The real purpose for which engineering schools were established is to increase industrial production, because the ultimate aim of engineering is more intelligent production. But every production project requires the co-ordination and adjustment of three factors, namely, scientific theory, mechanical practice and cost. . . . Therefore engineering education is likely to be more effective in proportion as it fosters the development of skill in determining the most expedient adjustments among theory and practice and cost. . . .

"It thus appears that an adequate treatment of the first element in production involves not only a scientific presentation of the laws of nature and the properties of materials, but also an estimation of the values and costs from both the material and the human points of view. The chasm between the school and practical life is due largely to a failure to appreciate this fact. The introduction of the study of values and costs in all their phases is the most direct method by which the schools can bridge this chasm. Such study is also one of the most potent means of liberating creative energy and developing the spirit of investigation."

Noting particularly the next to last sentence our older subscribers will recognize its complete accord with editorials that have appeared in this periodical for nearly 13 years. About seven years ago a professor of civil engineering wrote us stating that our articles and books on cost analysis and engineering economics had revolutionized the study and teaching of engineering. While appreciative of praise from so high a source, the editor felt that if any radical change in the teaching of engineering in all colleges was to be effected, many years of work yet remained for many workers. Prof. Mann's report shows very clearly that the so-called "commercializing" of engineering has not yet been accomplished in all engineering colleges. There is still a strong inclination to teach pure science apart from its application, and to give inadequate attention to analyses of costs and to other branches of economics.

Incidentally, we may add, Prof. Mann does not mention in his report the study of logic. It is true that no book on logic is ideal for the purposes of engineers, and that a good practical logic remains to be written; nevertheless, why the study of logic is not named as an essential part of every engineer's training is difficult to understand.

In a subsequent issue we will give extensive abstracts from Prof. Mann's report. Abstracts from the preface are given elsewhere in this issue.

## Who Is an Engineer?

To the Editor: In your issue of Dec. 4, under the caption, "Who Is an Engineer?" you present a very interesting discussion of a perplexing question. I am one of those who "has not studied the chapter on definition in several works of logic" and therefore have not an enlightened appreciation of "what constitutes a scientific definition."

I appreciate very fully, however, the difficulty of an all-inclusive and sufficiently exclusive definition of "Who Is an Engineer." I have tried to make such a definition many times and never produced a result upon which I could look and say, it is very good.

You urge objections to both Tredgold's and Krom's definitions, upon the ground that the element of good to mankind is given prominence. We must admit that the human mind can conceive and the human hand construct from the materials in nature something ingenious in design and produced with wonderful economy of material and labor which would be of no service to mankind and yet it would be the work of an engineer.

Again we must admit that this same human mentality can direct human power to produce scientifically and economically a mechanism which in its operation is extremely harmful to mankind, such as the engines of war whose function is to destroy life and property. The men who produce these things are engineers and their productions may benefit one group of mankind while it destroys another group and causes unutterable misery. The devilish manifestations of this class of engineering skill have been too evident upon the battlefields of Europe.

What we require is a definition suited to the pursuits and the needs of peace, and we want the kind of engineer who can "benefit mankind" by his knowledge; skill and experience. We want a human engineer, not a cold, abstract being whose effort is centered on a creation which has no relation to human welfare. We want human welfare paramount, promoted in the most scientific and economical manner possible of attainment. That is the thought in the Krom definition and that is the thought which for the good of mankind should dominate the mind of the engineer, no matter in which branch of the engineering profession he has enlisted for his life's work. The definition which is responsible for your editorial and this letter calls for the kind of engineer that the world needs. May his kind increase. ISHAM RANDOLPH.

Chicago, Ill.

# Sanitary Condition of Streets of San Francisco

To the Editor: In your issue of Nov. 13 I noticed some generalizations by you on matter published by the San Francisco Chronicle relating to the cleanliness of San Francisco's streets.

While this department of the city's administration is entirely outside of the scope of my activities, which are entirely confined to construction work, I cannot permit an untruthful and misleading libel copied from this journal to go unchallenged.

I just returned to San Francisco after a two months' visit which covered Washington, New York, Chicago, and some of the other principal cities in the United States, and during the past six years I have taken in other communities under my observation, and I can say truthfully, from personal observation, that the sanitary condition of streets of San Francisco is equal if not superior to those of any city that I may have seen. The cleaning of the streets of the city is under the charge of a bureau of the Board of Public Works with a very able engineer and superintendent, Mr. Owen, in charge. He has received continuous commendation from the storekeepers, public, and others who are interested in this work, and who would quickly criticise any delinquencies in same.

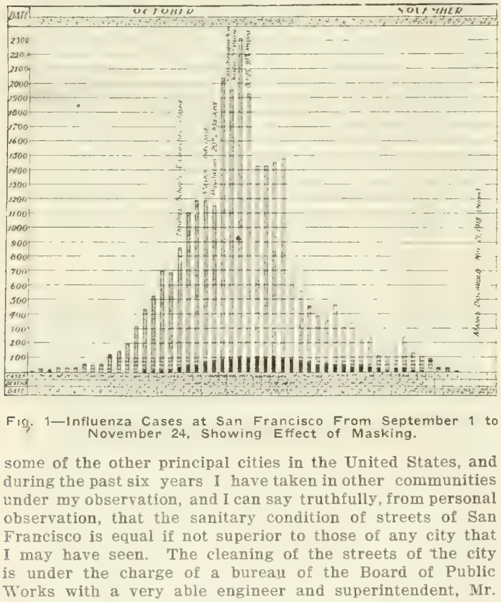


Fig. 1—Influenza Cases at San Francisco From September 1 to November 24, Showing Effect of Masking.

The record of health statistics of the United States demonstrates that this city is above the average from a health standpoint. Ours is the hilliest city in the United States, ranging from sea level to 800 ft. in height, hence no stagnant water rests anywhere in the city. Besides, a splendid modern system of arterial sewers has been constructed at a cost of $6,300,000, which is the most up-to-date in the United States. Before the modern era of 1900, when the new charter was adopted, the good old-fashioned street superintendent, who was elected by the public, had jurisdiction over the size of sewers, and a great many of the old sewers have been uniformly made of this size, 3 ft. by 5 ft. brick, regardless of the fact that an 8-in. or a 10-in. pipe would in most cases carry the drainage in small areas where those units were constructed. The present administration can assume no responsibility for the errors and malpractice of the past, which prevailed in most of our large cities before the value of the scientific sanitary engineer came to be appreciated.

It is a noticeable fact that the influenza epidemic has hit San Francisco lighter than it did any other city, which attests not only the excellent sanitary conditions prevailing, but also the resistant physique of our inhabitants. I am enclosing you the latest report (see Fig. 1) from the Health Board on the influenza condition, which has practically been exterminated in San Francisco.

We rather proudly claim precedence among other cities of having the best high pressure fire system in the United States, 72 miles in length, carrying 300 lb. pressure to the inch. This is necessary as about two-thirds of our city is built of wood, and we get a rebate of $1,000,000 a year in insurance rates, which pays over 16 per cent on our investment for fire system costing to date about $6,000,000.

We are the only city in the United States that has built and operated a municipality owned street railway system, costing about $7,000,000, at a profit. We have also spent $5,400,000 in traffic tunnels, have built the best group of municipal buildings in the civic center and in other ways take precedence in municipal activities in the United States.

M. M. O'SHAUGHNESSY,
San Francisco, Cal. City Engineer.

## Water Powers of the British Empire

The Water Power Committee of the conjoint board of scientific societies of Great Britain in its preliminary report issued in October, estimates the potential waterpower of the empire to be at least 50,000,000 to 70,000,000 HP. The committee further concludes:

(2)—That must of this is capable of immediate economic development.

(3)—That except in Canada and New Zealand, and to a less extent in New South Wales and Tasmania, no systematic attempt has as yet been made by any government department to ascertain the true possibilities of the hydraulic resources of its territories or to collect the relevant data.

(4)—That the development of the empire's natural resources is inseparably connected with that of its waterpowers.

(5)—That the development of such enormous possibilities should not be left to chance, but should be carried out under the guidance of some competent authority.

**Carrying Capacity of Some Old Water Mains.**—Interesting information on the results of tests of the carrying capacity of water mains is given in the annual report of the Water Commissioners of Hartford, Conn., for the year ending March 31, 1917. The following is a brief summary of the tests made in that city during the last few years:

| Street. | Size of main. | Age (years). | Chezy coeff. in $v = c\sqrt{rs}$. | Years of service under average conditions elsewhere to produce similar conditions in pipe. |
|---|---|---|---|---|
| Kennedy | 4" | 57 | 32 | 80 |
| Wooster | 4" | 58 | 28 | 90 |
| New Britain Ave. | 6" | 18 | 58 | 40 |
| New Park Ave | 6" | 13 | 40-70 | 20-70 |
| New Park Ave. | 6" | 41 | 48 | 65 |
| Blue Hills Ave | 6" | 15 | 80 | 15 |
| Lafayette St. | 6" | 60 | 36 | 95 |
| Farmington Ave. | North 20" | 37 | 69[1] | 60 |
| | North 20" | | 111[2] | 5 |
| | North 20" | | 75[3] | 45 |
| Farmington Ave. | South 20" | 25-40 | 75[1] | 45 |
| | South 20" | | 140[2] | * |
| | South 20" | | 95[3] | 15 |
| Park | 30" | 16 | 95 | 20 |

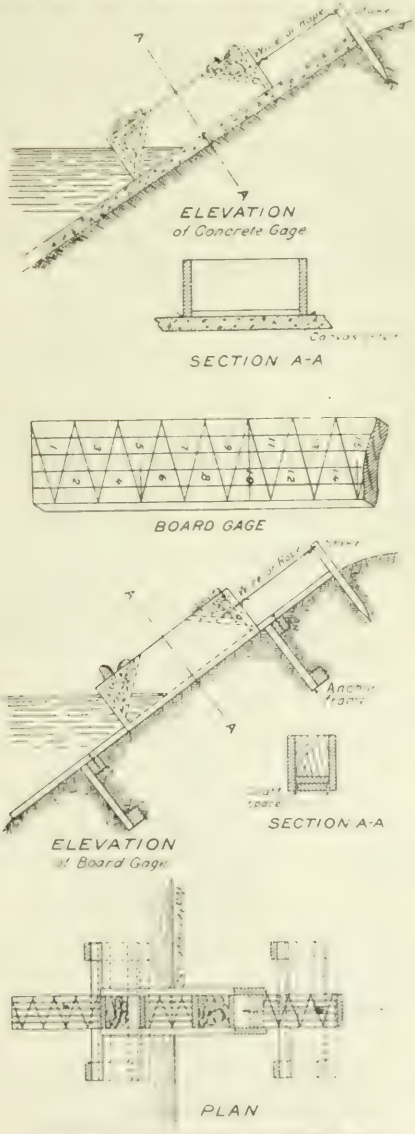
*Good new pipe. [1]Before cleaning. [2]Immediately after cleaning. [3]Four years after cleaning.

**Engineering Students at University of Illinois.**—The number of undergraduate students registered in the College of Engineering of the University of Illinois on Nov. 1, totaled 1,584. Of this number 84 were seniors, 133 juniors, 225 sophomores and 1,141 freshmen. The total enrollment in the University was 5,216. This does not include students in the departments located in Chicago.

# Graduated Slope Gage and Movable Stilling Box for Canal Measurements

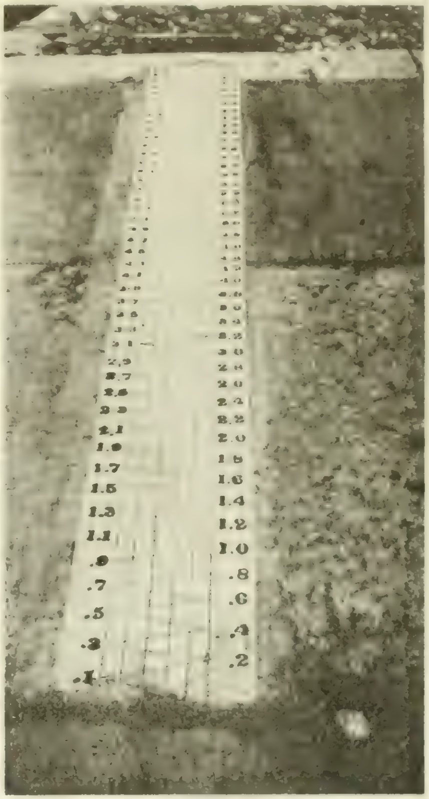
A combination of gage and stilling box that has given excellent results in measurements in irrigation canals is described by Mr. W. G. Steward, Assistant Engineer, U. S. Reclamation Service, in the November Reclamation Record.

The figures show the method of graduating the gage board or the markings on a concrete gage. The board can be any desired width with four equidistant parallel marks dividing the width of the board into five parts. The cross graduations are spaced according to the slope desired. The grooves and cross marks are cut into the wood about ⅛ in. wide and of about equal depth. The figures are easily and quickly cut with a V-shaped carving tool.



Plan and Elevation of Gage and Stilling Box

In practice the parallel grooves are cut in the boards at the mill and the graduations and figures are made in the field to conform to any convenient slope that may be found preferable. The foot points are determined with a level and rod after the slope and location of the board have been established.



Concrete Gage Set in Canal Lining

The anchor frames are set into the canal bank and the board fitted thereto, but it is not fastened till all markings are completed. By setting the anchor frames deep this form of gage resists the heaving of the frost.

The concrete gage is usually marked on canal lining or on the rating flumes while the cement is setting, and the graduations are made to conform to the particular slope used. The parallel lines and the cross graduations are readily made with a flat bar of iron which has been rounded at one corner.

A nail slightly bent at one end and filed smooth makes a good marking tool for the numerals. However, they are best made from dies cut on the end of soft wood blocks. With a small set of carving tools one can cut the necessary 10 dies in a short time. The blocks from which the dies are cut should be about 1½ in. square and about 3 in. long. The period is made with the blunt end of a lead pencil or a smooth rounded stick. By dipping these blocks in water immediately before using, the annoyance of having the wet concrete stick to them is avoided. Gages should be painted white and figures marked in black. This form of gage reads 0.02 ft. and can be estimated to 0.01 if conditions are good.

When the water surface fluctuates as it does in most canals, a simple and efficient movable stilling box is easily made and installed with the gage.

The stilling box for the board gage is built so that the sides extend over the sides of the gage board and the ends of the box rest on the face of the board. There is no bottom or top in the box. It should fit fairly close so as to prevent as far as possible any rapid influx and efflux of water due to wave action. The box may be weighted at either or both ends as circumstances require by placing therein shelves on which can be placed stones or other heavy material. The box is held in place by a wire or rope fastened to a stake or to the upper end of the gage. The box will give a closer record if it is not allowed to set too deep into the water; especially is this true if the current is swift.

In case of concrete gages where the surface of the gage is flush with the face of the lining or rating flume the stilling box is placed flat on the surface of the lining and its lower edges are padded with sacking or canvas tacked thereto to prevent too rapid movement of water between the box and the concrete.

This stilling box has been used on gages where there had been much uncertainty in the reading due to the wave motion in the canal and in no place has there been any further trouble. In one place where the wave motion was some 0.4 ft. the box reduced it to about 0.02 ft.

## "Doped" Water

It seems to be the popular belief among many people who have never taken the pains to find out what treatment the water undergoes, that, from time to time, large amounts of alum and other chemicals are dumped into the reservoirs. It is their belief that the mud and other substances with which the raw water is contaminated are mysteriously destroyed or changed to some invisible form, and, that when the water reaches the consumer, it is still impregnated with the chemicals used in the treatment. It naturally follows that, whenever any noticeable change takes place in the taste or hardness of the water, they immediately think of "chemicals" and complaints are the result.

One kind of complaint which frequently comes to us in the winter time is illustrated by a single instance. A lady informed me that she had had the hot water pipe in the furnace replaced four times within two years "because it became clogged with the stuff I was putting into the water." When asked how she knew what it was, she replied that that was what the plumber had told her. It took only a little explanation to convince her that the white deposit, which had stopped the hot water pipe, was not "the stuff we were putting into the water," but only the "temporary hardness" or "alkalinity," which is naturally in the river water; and that it had been deposited in the pipe because the plumber had persisted in placing the pipe so close to the firebed that the water in the pipe was boiling a great deal of the time.

The only way to get rid of this prejudice against "doped" water is by informing the public. A little explanation on the part of water works employes, and, perhaps, a courteous invitation to the complaining consumer to visit the plant and see the working of the process would go a long way toward converting him.—From the last annual report of Jos. B. Thornell, Chemist, Purification Department, Council Bluffs, Ia., water works.

**Cost of Garbage Incineration.**—The following figures on the disposal of garbage by incineration are given by W. T. Knowlton, Engineer of Sewers of Los Angeles, in a paper prepared for the 21st annual convention of the League of California Municipalities: The cost of construction of an incinerator varies from $200 to $1,000 per ton daily capacity, an average price being $600. The cost of operation and maintenance may vary from 50 ct. to $3 per ton. In Ohio the cost was found to vary from $1 to $2.60 per ton. For a 100-ton plant it is considered that the labor required will be 50 ct. per ton, the cost of collection an additional $2, making a total of $2.50 per ton of garbage for collection and disposal.

## Methods of Garbage and Rubbish Collection and Disposal in Larger American Cities

An investigation of the methods employed by various American cities for collecting and disposing of garbage and rubbish has been made recently by a committee appointed by the Mayor of Pittsburgh. This committee consisted of John A. Sauer, Superintendent of Bureau of Sanitation; F. F. Booth of the Division of Investigation, and of J. C. Slippy, Chief Accountant, Bureau of Costs. An abstract of their report follows:

**Baltimore.**—The city of Baltimore collects its own garbage, ashes and rubbish, and pays a private contractor for reducing the garbage. In the early part of 1918, Mr. Walter E. Lee, Water Engineer of Baltimore, was directed by the Board of Estimates to visit different cities and make recommendations for improvements in the service. The outstanding features of Mr. Lee's report were that rubbish should be disposed of by incineration, incinerators being established in several sections of the city, and that the city dispose of its garbage by contract, for reduction. The highest bid received was $23,000 per year, and the city decided to build its own reduction plant, entering into a contract with the Cobwell Corporation of New York. The Capital Issues Committee at Washington then intervened in the matter, and, on the ground that the adoption of either of the above plans would leave the present contractor's plant idle, requested the city to defer the construction of its plant for the period of the war, and continue the old contract (paying $75,000 per year for reduction).

The cost of collection of garbage is not kept separately, the collection of garbage, ashes and rubbish being performed by the Department of Street Cleaning at a total cost of approximately $225,000 per year, the total cost for collection and disposal of all city refuse being about $300,000 per year.

Men on collection wagons are paid $3.25 per day for 8 hours, one man being employed to each wagon. The city is divided into four districts with a stable in each and in charge of a superintendent, each district being subdivided into routes. The reduction company removes dead animals.

**Chicago.**—The collection of garbage in Chicago is performed by city force under the ward system, a ward superintendent in each ward being held responsible for conditions in his district. Thirty-five inspectors, one for each ward, look after garbage complaints. The garbage must be accessible to the collector and if not properly separated, the Health Department makes the householder remove it at his own expense. Two men are employed for each collection wagon and are paid $3 per day of 8 hours; $8 per day is paid for team hire, if driven by owner or his employe, the garbage wagon being furnished by the city.

Collections are not made from all hotels, as many of these sell their garbage to a private collector engaged in hog feeding. A private corporation pays the city $28,000 per year for privilege of removing dead animals.

The average cost per ton for collection in 1917 was $3.42, and for the first six months of 1918 this figure was $3.50.

The reduction plant was acquired by the city through condemnation proceedings several years ago, and additional machinery has been added from time to time. For this reason, the plant is not as efficient as one constructed under a complete scheme and engineered to meet all the necessities with a view of minimizing production costs.

In 1917, 4,023,480 lb. of grease and 22,680 tons of tankage were produced, the average price received for these products being $.0757 per pound for grease and $10.27 per ton for tankage, due to sale as a whole under annual contract. Prices for the five months beginning Aug. 1, 1918, will be $.1157 per pound for grease, and $16.85 per ton for tankage. The production of grease for 1918 has fallen 20 per cent under that for 1917. It was stated by the engineer in charge that in spite of this decrease the reduction plant would show a profit of $47,000 for the first six months of 1918 on reduction without municipal overhead or interest on investment charge or plant depreciation.

Analysis made in 1918 shows that a ton of raw garbage contains the following:

[illegible] per cent [illegible]
[illegible] per cent tankage
[illegible] per cent moisture and rubbish

Tests show that the grease produced in the plant contains 8 per cent glycerine.

A very complete cost keeping system is used by the Bureau of Streets, and the costs given are accurate but do not include interest and depreciation on the plant investment. The preliminary system of handling raw garbage in this plant is not considered sound practice by others in the work as the garbage is first submitted to a hot air dryer, only the steel sheets on the revolving drums being between it and the flames, thus carbonizing a percentage of the grease and tankage into inert and practically valueless matter.

**Cincinnati.**—Garbage collection and disposal in Cincinnati is performed by a private contractor under a lump sum contract, this contract expiring Dec. 1, 1918.

Two men are employed on each collection wagon. The city pays $3 per day for drivers and $2.75 per day for helpers on ash collections, and the contractor probably pays the same rate for garbage collection.

The amount of garbage for 1917 estimated at 48,000 tons.

Dead animals must be removed by contractors on notice.

**Cleveland.**—The city of Cleveland collects its own garbage and operates its own reduction plant at Willow, O.

The district system of collection, similar to the ward system in Chicago, is used. The average length of haul to the loading station is now from 4 to 6 miles. The construction of four loading stations, now planned, will reduce the length of haul to 2 miles, and cut the cost of collection accordingly.

One man is employed on each collection wagon, being paid $3.75 per day.

In 1917, 3,071,022 lb. of grease and 6,241 tons of tankage were produced from the garbage. This is sold under an annual contract, the prices received being $.135 per pound for grease and $18.82 per ton for tankage.

In May, 1917, the garbage yielded 3.23 per cent of grease. In May, 1918, this percentage had fallen to 2.57 per cent.

A few years ago the city of Cleveland had an appraisal made of all city property and this appraisal was written up in the auditor's books and kept under control currently, maintenance costs being charged as such and depreciation being written up yearly. The effect of this system is to place the accounts of the city, particularly those bureaus which are entirely or in part self-supporting, on the same basis as that of a private corporation.

The average cost for collection and disposal over the five-year period, 1913-1914, was $1.76 per ton.

The Cleveland city plant differs from that of Chicago in that the raw garbage is immediately placed in high tanks called digesters, and cooked under steam pressure, thus eliminating the deterioration in quantity and quality of the subsequent products, although the balance of the operation is more complicated and cumbersome, and makes a slightly higher reduction cost based on the amount of raw garbage handled than does the system in use in Chicago.

**Kansas City, Mo.**—Kansas City pays $57,000 per year to a private contractor for removal and disposal of garbage, 53,000 tons alleged to have been collected last year. The contractor feeds the raw garbage to hogs on a ranch located near the Kansas City Stock Yards. This contractor, C. Rhea, also operates hog feeding ranches at Nashville, Tenn., and Camp McClellan (Anniston, Ala.).

The Kansas City contract is for three years and calls for at least two collections per week from residences, and one per day from hotels, hotels and restaurants being permitted to sell their garbage to the contractor. No other person is allowed to collect garbage, although the contractor can sublet districts to other collectors. A bond of $25,000 is furnished to the city by the contractor.

The drivers of the collection wagons are paid $2.75 per day, only one man being employed on each wagon.

Sixteen inspectors attached to the Department of Health look after garbage complaints, but city officials stated that they were getting good service.

At the Kansas City ranch, garbage is fed on concrete slabs, these being washed each morning. No more odor is evident in this ranch than that common to the ordinary stockyard. The hogs used are first innoculated against hog cholera, the contractor averring that, in this operation he lost 5 per cent of the number treated. St. Louis, as a municipality, tried this experiment of hog feeding with garbage for a short time, but it was not wholly successful. Reduction plant pays 3 ct. per pound for dead animals.

**Milwaukee.**—The municipality owns and operates an incinerator and collects garbage, ashes and rubbish. Teams were secured for $4.50 per day in 1917, but the 1918 rate has increased to $6 per day. Collections are not made from hotels, these selling to private collectors who use it for hog feeding. It was stated that the ordinary household garbage carried an extremely small percentage of grease. Twenty-six inspectors look after complaints. In 1917, 46,979 tons of mixed refuse were burned at the incinerator at a total cost of $72,079, or $1.53 per ton. This per ton cost is applied to the total tons of garbage collected in arriving at the cost of incineration given. Steam is generated at the incinerator and furnished to the Milwaukee River flushing station.

Milwaukee requires the householder to paper wrap all garbage and place where immediately accessible for collection. The garbage wagons bearing these paper wrapped parcels were not noticable for odor from the sidewalk, and that factor was only discernible on closely approaching the vehicle. From the standpoint of unobjectionable service, this condition was only equaled in other cities where the garbage was similarly handled. Unfortunately, the system is fatal from a reduction standpoint, the paper absorbing so much of the grease, and there is no method for removing it, and, in addition, the labor entailed in unwrapping makes it out of the question. Dead animals are removed by city force.

**Minneapolis.**—Up to 1918, the city of Minneapolis disposed of its garbage by incineration, conducting both operations, collection and incinerations, with the city force. In the early part of this year, the city let a contract to the Reservoir Heights Pig Feeding Co. to take all the garbage delivered by the city f.o.b. cars at the central loading station, and pay the city $1.26 per ton delivered, the city using the paper wrapped method of collection. For collection purposes, the city is divided into 34 districts, a collector in each district being held responsible for the work in his district. Two men are employed on each wagon, the collector being paid $130 per month for his service with the team, and the helper, $2.80 per day for 8 hours, the city owning the wagons. The collectors haul their loads to three sub-stations, and from these points, the garbage is taken by wagon and trailer to the loading station. Collections are only made from residences, the hotels selling their garbage to private collectors.

The Minneapolis garbage is handled in a similar manner to that of Milwaukee, the householder being required to drain and wrap it in paper before it is placed in the cans. No tin cans, crockery or glass are allowed in the cans, the Health Department looking after proper separation.

An analysis of the garbage made in 1917 in all city wards showed that it contained only 1 per cent of grease. Dead animals are owner's property and sold by them.

**New York.**—The collection of garbage in the three boroughs of Manhattan, Brooklyn and the Bronx in the city of New York is under the jurisdiction of the Department of Street Cleaning.

The contract for disposal of garbage was with the Metropolitan By-Products Co., the contractor to pay the city the first year $120,000, with an increase of $30,000 per year for the remaining four years. This contract began operation on January 2d, 1917, to continue for a period of five years. The new Staten Island plant, using the Cobwell System, started operations in April, 1917, and, in December, was receiving all the garbage from Manhattan, The Bronx and Brooklyn.

**Philadelphia.**—The collection and disposal of garbage in Philadelphia is performed under lump sum annual contract,

TABLE I.—GARBAGE COLLECTION AND DISPOSAL IN AMERICAN CITIES—1917.

| City. | Population. | Area. sq. mile. | Population per sq. mile. | Amount collected. Tons. | Amount collected. Lb. per capita. | Cost of collection. Per ton. | Cost of collection. Per capita. | Net cost of disposal. Per ton. | Net cost of disposal. Per capita. | Net cost of collection and disposal. Per ton. | Net cost of collection and disposal. Per capita. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Baltimore ..... | 589,621 | 32 | 18,425 | 62,300 | 211 | ..... | ..... | $1.20 | $0.12 | ..... | $0.508†† |
| Chicago ....... | 2,497,722 | 198 | 12,615 | 100,146 | 80 | 3.42 | $0.13 | .31 | .012 | $3.73 | .14 |
| Cincinnati .... | 410,476 | 72 | 5,701 | 48,000 | 233 | ..... | ..... | ..... | ..... | 1.54 | .18 |
| Cleveland ..... | 671,073 | 53 | 12,718 | 56,121 | 166 | 4.20 | .34 | 1.80* | .14*† | 2.39 | .20 |
| Kansas City... | 300,215 | 61 | 4,921 | 45,000* | 299 | ..... | ..... | ..... | ..... | 1.26 | .18 |
| Milwaukee .... | 436,535 | 36 | 12,125 | 30,975 | 141 | 4.18 | .29 | 1.53 | .10 | 5.71 | .39 |
| Minneapolis ... | 363,454 | 54 | 6,730 | 20,834 | 114 | 3.87 | .22 | .95 | .05 | 4.83 | .27 |
| Philadelphia .. | 1,709,518 | 130 | 13,150 | 125,000* | 146 | ..... | ..... | ..... | ..... | 3.45 | .25 |
| Pittsburgh .... | 579,090 | 41 | 14,124 | 83,013 | 286 | ..... | ..... | ..... | ..... | 2.25 | .32 |
| St. Louis....... | 760,454 | 61 | 12,466 | 45,136 | 118 | 2.90 | .17 | .87 | .05 | 3.77 | .22 |
| St. Paul....... | 247,232 | 55 | 4,495 | 14,628† | 118 | 6.08 | .17 | ..... | ..... | 5.03 | .14 |
| Washington ... | 366,631 | 70 | 5,237 | 44,683 | 243 | ..... | ..... | ..... | ..... | 1.56 | .19 |
| New York[1]..... | 5,138,352 | .. | ...... | 403,665 | 157 | ..... | ..... | ..... | .... | ..... | ..... |

[1]Boroughs of Manhattan, Bronx and Brooklyn. *Estimated. †Total, of which 7,215 tons is collected by city. *†Revenue. ††For garbage, rubbish and ashes.

the amounts for the last few years being as follows: 1917, $132,000; 1918, $575,256; 1919, $486,000.

No check is kept on the amount of garbage collected, except that the total amount collected during some month is weighed and thus used as the average. Inspectors keep close watch on complaints, being required to turn in a report on the complaint 48 hours after its receipt. The contractor is fined $1 per day for each house which he fails to collect from.

**St. Louis.**—Garbage is collected in St. Louis by city force and delivered to a contractor at dumps on barges and is then transported to the reduction plant at their expense. The city pays $.87 per ton to the contractor for disposal and the contractor stated that he was willing to renew at that figure, but would not accept less or pay any bonus for it.

The district system, similar to that of Chicago, is used in collection. One man is employed on each wagon, he being paid $75 per month for 8 hours per day. The average length of haul to the dumps is, at present, 4½ miles, but the engineer stated that, by the construction of loading stations, this could be cut to 2¼ miles. Four inspectors attached to the Department of Streets and Sewers, look after complaints.

**St. Paul.**—About half of the garbage in the city of St. Paul is collected by the city, and the balance by 54 licensed collectors who pay a license fee of $5 each per year. Garbage collected by the city is delivered to hog farms just outside the city limits, selling at an average price of from $1 to $1.25 per ton.

Teamsters on city collection are paid $100 a month, and furnish the teams and running gear, and the city, the wagon boxes. City wagons are provided with an opening for draining each load, before being delivered to the contractor.

The length of haul is much higher in St. Paul than the average city, as the garbage is hauled about 2 miles further out of the collection districts than would be required if some other system of disposal were adopted.

There is no regular collection of refuse and ashes, the householder being required to dispose of these by having them hauled away by the licensed scavengers at his expense.

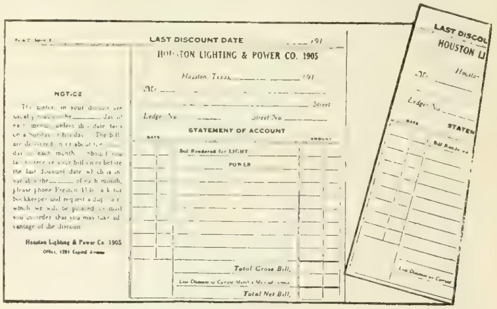
## Work of Division of Engineering to Be Continued

The work of the Division of Engineering of the U. S. Employment Service is already known to thousands of technical men who registered during the war. Many of these men were placed in positions that made them very useful in the projecting of the war. Others were placed, to their advantage, with important concerns, while many others were still maintained for the development and research with the Government. It is gratifying to know that this work will be continued for reclamation and reconstruction. This service, the first of its kind in the history of the United States, is free of charge and for anyone who desires it. The registration blanks can be obtained from A. H. Krom, Director of Engineering, 29 S. La Salle St., Chicago, Ill.

## New Bill Form Has Useful Features

The new form of monthly light and power bill recently placed in service by the Houston (Tex.) Light and Power Co. contains certain features that might well be adopted for water bills. The Houston form, states the Electrical World, provides space for the statement of account, a notice to the consumer and a duplicate bill, all in one sheet. The duplicate bill folds over so that the customer receives a carbon copy and the original is held in the office. This is very desirable in view of the large number of requests that are received each month for duplicate bills.

It was felt that the amount of labor involved in handling consumer accounts could be relieved considerably if the customer could be kept advised as to when to expect the meter reader and the date on which his bill may be paid in order to secure the discount. By the use of the new form this has been accomplished. Also, this form automatically provides a duplicate bill which can be held in the office, ready when the consumer calls and says the bill has been mislaid or not received.



LAST DISCOUNT DATE 191

HOUSTON LIGHTING & POWER CO. 1905

Houston, Texas, 191

Mr.

Street

Ledger No. Street No.

STATEMENT OF ACCOUNT

DATE AMOUNT

Bill Rendered for LIGHT

POWER

Total Gross Bill,

Total Net Bill,

NOTICE

Houston Lighting & Power Co. 1905

Electric Light Bill That Does Not Contain Meter Readings.

It has been the experience in Houston that about 90 per cent of the customers who apply for duplicates have either misplaced their bills or failed to bring them along. As a check on the bill deliveries, however, the bookkeeper asks each customer if he receives his bills regularly, and there is an investigation of all cases where trouble is reported. Very frequently the customer knows the amount of his bill and all he wants is a receipt for the amount and the last date of reading. Under the present system this is now ready for him. As a rule the customer is not interested in the actual figures of the meter reading and, therefore, this information has been left off the new Houston bill.

By the use of an indelible pencil the bill need only be filled but once, and the form provides itemized information so that it is not necessary to again refer to the ledgers in case of inquiry, and the customer is advised definitely as to the date of meter reading and the discount day.

**War Gardens Produce $525,000,000 Worth of Food in 1917.**—According to a report of the National War Garden Commission the 5,285,000 war gardens in the United States in 1918 produced food valued at $525,000,000, an increase of more than 50 per cent over that grown in 1917.

# Need of Raising Water Rates to Offset Increased Costs*

By JOHN J. MOORE,

Owner and Manager of Water Companies, [illegible]

In a general way, the cost of materials used in operating water plants has advanced all the way from 150 to 250 per cent. Fuel and wages have advanced 100 per cent. Figures which I quote are taken from the records of companies in which I am interested and in all of which we have either increased or asked for an increase in the water rates.

In one Massachusetts company 8 or 9 years ago we were paying to the town in taxes 50 per cent less than what we were receiving from them in hydrant rental. Last year we paid them $1,300 more in taxes than we received from them in hydrant rental; that is, the amount paid to them was 30 per cent more than the amount received from them.

In another Massachusetts company the taxes have advanced 43 per cent in the last 5 years.

Operating costs in both of the above mentioned companies have advanced during the last year in percentages varying from 50 to 80 per cent. Where oil is used as fuel the increase is between 50 and 60 per cent. Where coal is used, the increase is about 80 per cent. Wages of pumping stations have advanced from 30 to 45 per cent. Wages of engineers have advanced 50 per cent. Day laborers have advanced 60 per cent over 1917, which showed at least 30 or 40 per cent advance over previous years.

Companies which two or three or even one year ago were earning an average of 8.8 per cent on the capital stock are today earning 6.3 per cent. Companies which were earning, a year ago, an average of 4½ per cent on the capital stock are today earning a little less than 2 per cent on the capital stock.

This, in brief, is the problem many water companies are today facing. The question is, how to meet it. There seems to be only one way, and that is to raise the rates.

Probably the greatest question is how and where to get the increased rates. There is a question now as to what proportion of rates the towns should bear as compared to that paid by domestic users. The old idea was that the town should get all it possibly could for the lowest rental. In the West it has been held by public utility commission that the cost of building and maintaining a system of water works giving fire protection to a town or city is about 66⅔ per cent more than the cost of a system supplying water for domestic users only, and therefore the proportion of the burden of supporting a public utility in such a way as to render efficient service to the town or city should be greater for the town or city rather than for the domestic users.

In a recent decision given by the Maine Public Utility Commission it was stated that 25 per cent of the total revenue necessary to operate a company and pay a fair return on the investment was not too large for the town to pay. (Guilford, Me.)

It is a much fairer adjustment of rates for towns and municipalities to bear the larger portion of the revenue required by water companies, but it becomes a matter of educating townspeople to this idea.

In a recent decision in Pennsylvania, the commission decided that a water company should be entitled to earn, in addition to the expense of operation and annual depreciation, a 7 per cent return on the value of its plant. (York County Water Company.)

In another decision the same commission decided that a water company in a town where they ordered certain improvements should receive an 8 per cent return on the valuation fixed by the commission. This valuation, by the way, was fixed by the commission as only $15,000 less than the book value of the company. (Montrose, Pa.)

The California Commissioner also considers a net return of 8 per cent on the valuation as a fair return. Taking an example a little nearer home, the Maine Utilities Commissioners have, in a decision rendered in 1917, stated that they consider 6 per cent net income on the fair valuation of the properties of a water company a fair return on the investment justified?

I believe that instead of increasing the domestic rates to meet these increased expenses to which the companies have been put on account of the increased cost of fuel and labor, so as to pay the stockholders a fair return on their investment, the towns and cities should pay a larger hydrant rental. In Massachusetts the towns pay a fair hydrant rental, but they get it all back in taxes. One company paid, last year, $1,300 more in taxes than it received for hydrant rental. Now, there is no question but what the company was the cause of a big growth in that town. When the company was installed, about 17 years ago, the town had a valuation of about $3,000,000, while they now have a valuation of $12,000,000. At that time there were about 67 takers; now there are 1,200 to 1,400 water takers. The company asked the town to call a town meeting and increase the hydrant rental, which they refused to do, so the company has brought it before the commissioners to have them decide—which they have a right to do—whether the town shall pay a larger hydrant rental or the people shall pay a larger water rate.

In one of the towns in Maine where we had this same thing come up, we went to the town meeting and put it up to them in this same light, and they voted to increase the hydrant rental 200 per cent a year. I believe this is the fair way, because in all these towns there are miles of mains that are running by building lots that have more than doubled in value, and the owners are not paying anything at all for the use of the main. I believe that, by taxing those lots, and every other lot in the town in proportion, that is a fair way to get at the increased revenue that will have to be raised in order to give these water companies a fair return on their investments. I do not know of any of the water companies in this state (I am interested in three) that are earning more than a fair return on the amount of capital that is invested—none are earning over 6 per cent—and I know of a number that are not paying any dividend at all, and never have earned money enough since they have been doing business to pay any. Since the increase in price of fuel and labor has occurred, on account of the war, some of the gentlemen who are interested in them tell me that they are not earning their operating expenses.

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*From the Journal of the New England Water Works Association. Abstract of paper presented at the September meeting.

## Frost Penetration Last Winter

The report of the Committee on Frozen Water Mains of the New England Water Works Association, submitted at the September meeting of the association, includes much information on the frost conditions encountered last winter in various sections of the country. Forty-three cities reported that frost was noted at depths of 6 ft. or over. In 57 cities the average depth of frost penetration was 4 ft. or over, while 27 cities reported an average depth of 5 ft. or over. The greatest depth noted, 9 ft., was at Duluth and St. Paul, Minn. In the first city the penetration was in clay, and rock soil; in the second it was in sand and gravel. At St. Paul the average depth was 7.5 ft. Depths of 8 ft. were noted at Winnipeg, Man., in gravel soil and at St. John, N. B., in clay soil.

**Leakage from New Water Mains.**—All important sections of new mains in the distribution system of Hartford, Conn., are subjected to a hydrostatic test for leakage before being put in service. Between March 1, 1916, and March 1, 1917, 56 sections were tested at a test pressure of 100 to 125 lb. per square inch. The following tabulation from the report of the Board of Water Commissioners, for the year ending March 1, 1917, shows the results of the test:

| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 56 | [illegible] |  |  |  |  |
| [illegible] | [illegible] |  |  |  |  |

[illegible]

# Instructions for the Operation of Sewage Plants

The following schedule of operations for the satisfactory and effective working of sewage plants is abstracted for a bulletin issued recently by the Bureau of Sanitary Engineering of the Texas State Board of Health:

**Septic Tanks.**—Great depths of scum should not be allowed to form on the surface of the liquid. This should be frequently broken, liberating the entrained gases and allowing the solids to settle where more active decomposition will take place. A stream of water under good pressure can be used to good advantage for this purpose.

Remove sludge from bottom of septic tank at least once in every three or four months.

This sludge should be spread on drying beds in order to facilitate the dewatering of same, after which it can be either burned or carted away.

**Grit and Screen Chambers.**—Do not allow deep accumulations to grit to remain in the grit chamber. This grit should not be allowed to wash into the settling chambers, but should be disposed of outside of the tanks. Clean screens once every day. Record date of cleaning, amount of screenings, how disposed. Bury or burn screenings as soon as removed. Flush bottom of screen chamber as needed. There will probably be some heavy matter which will not be caught on the screen, but which may lodge back of the screen, and this should be flushed out before it has started to decompose. Specified intervals cannot be given for this flushing, but a careful watch kept for these conditions will enable the operator to know when to flush.

### Imhoff Tanks.

**Channels.**—Keep channels clean at all times. Flush out deposits once a day in winter and twice a day in summer. Clean channels thoroughly before reversing flow in tanks. Deposits are most likely to occur in the channels at the inlets to the tanks. Care must be taken that these deposits are washed into the tanks and are not allowed to get into the outlet channels. Before reversing the flow through the tanks, be sure that the channel which is to become the outlet channel when flow is reversed, is thoroughly cleaned and that the deposits are swept into the tanks. Deposits in channels tend to cause odors.

**Settling Compartments.**—Skim off oil, grease and all floating matters at least once every day. Dispose of oil and grease outside of tanks. Do not let oil from barrels get into catch basins. Floating materials, such as matches, corks, rubber goods, etc., behind baffles and all scum collecting upon the surface of the sewage passing through the chambers should be removed. This can be done by means of a dish-shaped perforated skimmer, perhaps 18 to 20 in. in diameter, attached to a long wooden handle. The scum and floating material may be thrown into the scum chambers. Clean sides and bottoms of settling compartments once a day in winter and twice a day in summer. This may be done with a rubber squeegee, a flat hardwood board from 12 to 24 in. long and from 3 to 4 in. wide with rubber edges and a light wooden handle of length determined by the dimensions of the chambers. Clean slots once a day. Reverse flow in tanks every two weeks. Remove all floating matter between scum boards and end of tanks before reversing flow. In cleaning down the sides of the settling chambers the cleaner should be moved slowly and the deposits removed from the sides forced through the slot into the sludge chambers. This is especially necessary at the outlet end of the tanks so that the matters scraped from the walls are not stirred up and carried away into the outlet channels. See that every part of the tank is cleaned, for if deposits adhere to the sides and decompose odors are sure to result. At times of reversing flow, clean down thoroughly all parts of the tanks between the scum boards and the end of the tank at the inlet end (or what will be the outlet end when the flow is reversed). After the deposits which have been stirred up in cleaning have been settled, reverse the flow. Most of the floating matter on these tanks can be made to settle by sprinkling with water. Oil and grease, however, must be skimmed off and removed from the tank.

**Sludge Chamber.**—Measure and record depth of sludge once a week. This may be done by means of a weighted board or sheet iron plate from 12 to 18 in. square attached to a wire or cord or to a long light rod of wood or gas pipe. Stir up sludge once a week with pressure water through perforated lead pipe. Excessive scum formation can sometimes be checked by the occasional use of this perforated pipe. When this is done some of the gas in the sludge is driven off and there is consequently less tendency for it to rise into the scum chambers. Furthermore, if the activity of the organisms in the sludge seems to be retarded, due to the excessive formation of so-called enzymes or other by-products of their existence, these may be disseminated and diluted by spraying water through the perforated pipes in question. Never let sludge get to such a depth that its upper surface is nearer than 18 in. to the slot. Measure and record depth of sludge about two hours before and after removing sludge. Remove sludge about every two months. Flush sludge pipes with pressure water after removing sludge. About an hour before removing sludge, open valve for a few minutes so as to loosen up the sludge about the sludge riser pipe. This should be done some time before the sludge is drawn, so that the sludge has time to settle; otherwise partly digested sludge may be withdrawn to an objectionable extent. To remove the sludge, open the valve at the sludge riser, the pressure of the water above will then force sludge into the pipes leading to the sludge bed. If from any cause the sludge pipe should become clogged it may be cleaned by pushing a rod through it or forcing water or clarified sewage through it under sufficient pressure. Sludge should be removed from one pocket of the tank at a time. It is better to remove smaller amounts of sludge at frequent intervals than to withdraw large quantities infrequently. After withdrawing sludge, the sludge pipes must be flushed. This can be done by opening the valves or by back-flushing from water connections. The water used in flushing should be discharged upon a section of the drying beds on which there is no sludge. The line leading to the beds may be back-flushed, if necessary, by putting water from a hose in the pipes at the beds. Water must be kept at the sludge drying beds. If partly digested sludge appears, the valve leading to the bed must be closed at once. Partly digested sludge can be recognized by its grayish color, and by its foul odor. Digested sludge is brownish-black, with only a faint tarry or rubbery odor, which disappears in a short time, leaving the sludge with an odor similar to garden soil.

**Gas Vents or Scum Chambers.**—Break up scum in gas vents daily. Record distance from top of scum to top of walls. Record appearance and odor of scum. If the floating scum or sludge which collects in the gas vents cannot be broken up by sprinkling with water, then it will have to be broken up with a pole, spade or otherwise. Large quantities of scum must not be allowed to collect in the gas vents. All matter which will not settle by sprinkling or agitation, should be removed from the tank and burned. Great depths of scum will not digest properly and may give off more or less offensive odors of decomposition. No decomposing material should be allowed to accumulate in these chambers, otherwise septic action may take place and disagreeable odors be produced.

### Sludge Drying Beds.

Put sand on beds before putting on sludge. Put sludge on beds preferably to a depth of about 6 to 8 in.; never over 12 in. Make the necessary measurements and records called for by the operating sheets. Before applying sludge to the drying beds, a thin layer (about ⅛ in.) of sand or very fine stone should be put on the beds. This will prevent the sludge from working down into the stone on the beds. Never put partly digested sludge on the drying beds, but bury at once. Do not put freshly withdrawn sludge on top of sludge already on the beds, as it will not dry quickly. Do not remove from the drying beds sludge which is only partly dried. Wet or freezing weather interferes with the drying of sludge, so that it is better not to withdraw sludge during wet or freezing weather. After drying, sludge may be used as a fertilizer upon lands, or it may be used for filling in low places. It is well worth hauling away and utilizing upon cultivated lands. It has the advantage of being able to lighten heavy soils and would no doubt furnish humus to soils which are lacking in this feature. When deposited in fills, the thoroughly digested sludge does not undergo putrefaction and will not cause any nuisance due to odors. Measurements should be made as soon as the sludge is placed on the beds and just before removal from the beds. Weather conditions should be carefully recorded.

### Dosing Chamber.

All floating matter which may have passed through the settling chambers into the dosing chamber must be skimmed off. These matters if allowed to discharge will clog the nozzles of the filters. Clean down sides of tank and do not allow accumulations to adhere thereto. Clean bottom of tank whenever any appreciable amount of matter remains in same after discharging. See that all pipe connections to the siphon are perfectly tight. If joints are not air tight, the siphon will not discharge properly, if at all. If screens are placed in dosing chamber, clean same daily.

### Sand Filters.

Except in emergency cases no sand filter shall be used continuously for more than one day, but should be dosed alternately, arranging so that one bed can be cleaned and rested without interfering with the successful operation of the plant. Every morning before dosing beds they should be raked lightly to a depth of ½ in. with fine sharp rakes. When the surface of the filter sand becomes so clogged that the sewage does not percolate into the filter, allow bed to rest until the surface is dry and then rake the sand to a depth of ½ in. or slightly deeper. When this will no longer increase the porosity of the surface sufficiently to permit the sewage to percolate, put the filter out of use and after resting and drying, scrape off and remove the clogged surface of sand to a depth of approximately ½ in.; then loosen the surface lightly with sharp pointed rakes; then allow bed to rest at least one day before again putting into service.

### Contact Beds.

The surface of the stone should be kept at a point 3 or 4 in. above the water level in the beds. This will prevent the attack of flies on the sewage. The automatic control apparatus must be kept in perfect operation at all times. After a service of 5 years, more or less, the contact material becomes filled with sewage solids and will have to be removed, cleaned and replaced.

### Sprinkling or Trickling Filters.

The nozzles should be examined every day and thoroughly cleaned. The side walls should be carefully washed down, and kept free of dirt, flies and gnats. The main drains should be flushed out at least once a week with water under pressure. If dirt and dust settles on top of filter same should be removed and the bed washed with water so as to prevent clogging. Keep the bed free from leaves, papers, etc. If the mat which forms on top of the filter becomes so thick as to prevent the percolation through the filter, it should be raked off and the bed carefully washed with water.

### Activated Sludge Method.

The purification of sewage by aeration in the presence of activated sludge is still in its infancy, and the varied character of plants being built forbids the giving of full instructions covering all of the details of operation. Each plant will have to be governed by special instructions of the engineer in charge, but a few general directions may be given as follows: All dust and oil should be excluded from the air introduced. The presence of grit seriously affects the process, hence attention should be given to the grit chambers to see that they are functioning properly. All sewage should be first screened before entering aeration chambers in order to remove all indestructible matter such as rags, orange peelings, matches, corks, rubber goods, etc. A close observation must be kept on the operation of the diffusers (filtros plates, wooden diffusers, or perforated pipes) in order that the maximum efficiency may be derived. Air should be delivered in large quantities of very small bubbles distributed through the entire cross section of the tank, rather than large bubbles in portions of the tank. Broken diffusers, or diffusers which have become worn or clogged will not operate properly. Provision must be made for the de-watering of the sludge. This may be done by providing large sand areas upon which it may be dried or by providing suitable presses for the purpose. In drying the sludge upon sand beds a larger area is required than for Imhoff tanks sludge and it should be placed upon the beds in thin layers as it dries very slowly. One method which seems to be especially favorable to Texas conditions is the mixing of lignite dust with the sludge as it is withdrawn from the tanks, subsequently placing this mixture upon the sand beds to dry. This mixture dries much more rapidly than the unadulterated sludge and after drying may be used as a fuel, thus disposing of the sludge as well as utilizing the dust.

### Chlorination.

The amount of chlorine to be used shall be determined by actual tests and there shall be left posted in the chlorination house a chart giving the amount of dose required for various flows of sewage effluent, and shall also state in detail the method of operating the chlorinating apparatus. The operator shall not make any change or adjustments in the equipment other than regulating the flow or dose without first receiving permission from the superintendent in charge.

### Measurement of Sewage.

The flow of sewage into the tanks should be measured from time to time in order to obtain the volume of sewage entering the tank. Where daily tests are made on the effluent it will be necessary to know the amount of sewage being treated to arrive at an intelligent conclusion as to the purification perfected.

### Sampling and Testing.

Make tests of the amount of the settling solids in the raw sewage and the tank effluent every day at 2 p. m. by the use of conical glasses. Make putrescibility tests every day of samples of the raw sewage, tank effluent and final effluent. These results of putrescibility tests with methylene blue should be recorded on a percentage scale in terms of stability as recommended by Professor Phelps of the United States Public Health Service and listed on page 38 of Fuller's book on "Sewage Disposal." Make bacterial tests every day at 2 p. m. corresponding to sample in the schedule above stated for putrescibility tests.

### Records of Operation.

Keep full records of results of operation at the plant, posting the results with a pencil in white line prints of the record form. These pencil records should be signed by the attendant and sent to the State Board of Health after the Sanitary Commission has looked them over carefully with the attendants. On operating sheets should be kept a complete record of all data touching on the operating features above stated. In addition there should be a complete record of the height of water in the stream into which the effluent is discharged, and in the operation of troubles, such as odors, unsightly conditions in and around the plant, all of which unusual features should be put onto the records under "Remarks." The attendant should keep a diary at the plant to record any unusual features that do not appear on the pencil notes on the operating sheets. The diary should record the receipt, or the ordering, or the need of any new supplies, or changes at the plant. The diary should show the presence of any number of extra workmen employed and what they do. It should show visits from any of the machinery concerns and the cause of their visit. It should deal with the special things and the operating records should deal with these things which are of regular occurrence. The diary, together with the operating records, should give a complete history of the plant from day to day and the attendants should be taught not to be afraid to put down things which seem adverse or unfavorable to them, because the record of such observations is the surest way of leading to a prompt and satisfactory remedy of unsatisfactory items and the improvement in operating conditions as the flow of sewage and other factors change from time to time.

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**Annual Meeting of National Drainage Congress.**—The National Drainage Congress will hold its 7th annual meeting in Chicago, Ill., Dec. 13 and 14, 1918, at the Y. M. C. A., 19 S. La Salle St. The ablest engineers, statesmen, lawyers, business men, scientists and contractors will take part in the program.

# Garbage Disposal by Feeding to Hogs

The United States Food Administration in a bulletin on garbage disposal issued last February, gives the following information on the hog feeding method of disposing of garbage:

The test of the practicability of the feeding method of disposal is the selling possibilities of the pork produced. There is no benefit in feeding if the pork is unfit for food or if a popular prejudice will prohibit it from selling freely.

Of the 66 cities estimated to have in excess of 100,000 population in 1916 by the United States Census Bureau, 20, or over 30 per cent, report that their garbage is being disposed of by feeding to hogs.

**Garbage-fed Hogs Not Inferior to Grain-fed Animals.**—If garbage-fed pork is inferior to grain-fed, the price paid by the packers, who are naturally adverse to paying full price for an inferior article, should indicate the fact. We have not been able to find any market where garbage-fed hogs are being generally sold at a lower price than grain-fed animals. When cases of "softer" pork have been noted it has generally been found that the animals were improperly raised, kept in small pens and not allowed to exercise. There is no theoretical reason why garbage should be bad for hogs. Even putrefying materials may be transformed into delicious human food; for example, lobsters, crabs, shrimp, etc., feed almost exclusively on decaying fish; and the common barnyard chicken will eat and thrive on almost all kinds of so-called filth.

The chief objection to garbage-fed hogs is that such hogs are alleged to be infected with trichinosis. There are no data available to support such claims; isolated cases have been found, as with grain-fed stock, but we do not believe that there is any evidence today that shows garbage-fed hogs, as a class, to be more susceptible to either trichinosis or tuberculosis than grain-fed.

Recently, at a meeting in Chicago, the statement was made that garbage-fed hogs were particularly likely to be infected with tuberculosis. This statement was promptly challenged by an official of the Massachusetts Bureau of Animal Industry, a specialist in the diseases of garbage-fed hogs. He said that such a statement was no more justified, from available data, than a statement that because 90 per cent of the hogs from a certain county of a Western state showed lesions of tuberculosis on autopsy, it followed that the feeding of grain caused tuberculosis. There is a well known reason for the large percentage of corn-fed hogs found infected, and there is likewise a well defined reason for the few cases where garbage-fed hogs have been found with a large percentage of tuberculosis.

**Management Secret of Success with Garbage-fed Hogs.**—The secret of success with garbage-fed hogs is, as with grain-fed hogs, largely one of management. The man behind the hogs is the prime consideration. It requires hard work, no little knowledge of hogs, and a large amount of common sense to raise garbage-fed hogs. Cities undertaking municipal hog-raising must remember that the pigs are to be fed on garbage; not on politics. The men who are making a success in this work are up early and late, are progressive, know their hogs, and have a distinct knowledge of what they are doing and how they are doing it.

A number of tests have been made which establish that a gain of about a pound per day can be expected with growing hogs. This means roughly that a ton of garbage is equal to 100 lb. of live weight gained. It does not mean, however, that tons of garbage as produced multiplied by 100 equals the live weight to be put on the market. A certain percentage of loss in stock is always to be expected, and even with the fullest co-operation with householders, city officials, etc., a certain amount of inedible material, and even inedible garbage, will always be present.

Some feeders are stating that the quality of the garbage now produced is not as good as that of a year ago—that more garbage must be eaten to produce a pound gain. This is not definitely established, but it is reasonable to suppose that with high prices, etc., the quality is not as good. We recommend that to cover losses and a possible decrease in the quality of the garbage fed, the amount of marketable live weight be assumed at 1 lb. to 50 lb. of garbage. With careful management the ratio could be lowered considerably.

**Municipal Collection of the Garbage Favored.**—Special efforts should be made on the part of the city to collect by municipal forces even though disposal by contract is deemed advisable. The municipality can generally overcome collection difficulties better than a contractor. With contract collections, details must be definitely stipulated and cannot readily be changed as conditions alter. With municipal collections changed conditions can be readily met.

It is also believed that more competition can be obtained on a contract for disposal only than on a contract for both collection and disposal. The difficulties experienced with disposal are not so detailed as with collection. Collection of garbage is a public utility, whereas disposal is a private affair in which the public is not interested, and, up to the present, has had no wish to be interested.

The ratio of 1 lb. of marketable pork to 50 lb. of garbage has already been established. With pork on the hoof at 15½ ct. this would give gross feed value of $6.20 to a ton of garbage. From this amount must be deducted the cost of labor and materials at the farm, any haul involved, interest on investment, depreciation on buildings, and profit.

**The Hog Farm.**—The distance of the farm from the municipality naturally depends on local conditions. With wagon or truck haulage, distance is an important factor, but with carload lots an additional 10-mile haul adds very little to the freight rate and a more ideal location may be selected.

The pig farm should be located on soil that drains readily, preferably sand or gravel. For the same reason it is advisable that the land be rolling; the houses should then be located for warmth in winter and coolness in summer. Good drainage is essential at all seasons.

Garbage-fed hogs require abundant drinking water. If any streams or brooks are included in the property they should be carefully traced and their purity established or else fenced off so that the animals will drink pure water otherwise supplied.

The size of the farm necessary varies with the system of handling. With feeding out of doors in all but extreme weather, assume 50 pigs per acre. Under cover the number can be increased to from 400 to 600 an acre.

Most garbage is more or less a balanced ration and no supplementary feeds are required. We find, however, in a number of places that animals are finished off with corn; in others wheat, middlings, or similar feeds is given to brood sows, or corn silage is fed on Sundays. As a rule, however, no feed other than garbage is provided.

**Selection of Hogs.**—There is much controversy between garbage feeders as to the relative merits of hogs raised on garbage from birth and those purchased on the market when at around 100 lb. in weight. Some claim that the garbage-fed hog has not the strength of the other hog; others will only handle feeders when their regular stock proves inadequate to consume the amount of garbage being produced.

Unquestionably a hog raised from infancy on garbage should be the more successful. The feed is much more bulky than with grain and requires a greater stomach capacity if the same amount of nourishment is to be assimilated. The hog raised on garbage is started as a garbage-fed pig, his stomach is capable of being distended far beyond that of a grain-fed hog of equal age.

Practically every garbage feeder believes that the material he is feeding contains considerable hog-cholera virus, and that instead of being exposed to the disease once or twice during their lifetime his animals are exposed daily. Immunization is accordingly of far greater importance than with grain-fed stock.

Constant exposure to cholera virus will undoubtedly build up a considerable resistance to the disease. Where garbage with its virus content has been fed for a number of generations a higher resistance is to be expected than with grain-fed herds. This higher resistance causes the disease to be less acute, but the garbage feeder must recognize that his hogs are exposed to considerable hog cholera and that immunization is absolutely required.

# Method of Thawing Frozen Water Mains and Sewers

An investigation of conditions in water distributing systems arising from the severe cold of the winter of 1917-18 has been made by a committee of the New England Water Works Association. The report of the committee, submitted Sept. 11, is printed in the Journal of the Association, from which the following notes are abstracted.

Very few of the active superintendents and managers of today have ever experienced such a condition as prevailed from about the middle of November, 1917, until the middle of March, 1918. Unusually long stretches of extremely cold weather and an absence of snow made ideal conditions for the penetration of frost.

The following data, compiled from the records of the United States Weather Bureau in Boston, Mass., clearly show the unusual character of the weather the past winter:

| | Degrees |
|---|---|
| The average mean temperature for last December, January and February was | [illegible] |
| The average normal temperature for the same months for the past 48 years was | [illegible] |

Depths to which main pipes and services were laid seemed to make little difference, for in the localities where pipes were laid according to the average frost penetration of previous years, the frost went just a little deeper this year.

Aside from the inconvenience and danger of sickness through lack of sanitary arrangements caused by frozen services, frozen hydrants were the cause of much worry and a great amount of labor to the man in charge, and of danger to the community. Not only did they freeze, due to slight leaks on the valves and the entrance of ground water through the drips, but in some soils they were raised by the action of the frost on the ground so that they were severed from the lateral. Many more cases have been reported of hydrants broken off above the valve, the break not being discovered until the hydrant was used, or upon inspection during the spring and summer. It is probable that much more hydrant trouble has occurred than has been reported, owing to the lack of regular inspection of hydrants by the smaller towns.

It would seem that it made no difference whether a meter was set in the cellar or in a box outside, although, if an explanation from places showing a small percentage of outside meters frozen could be had, it might appear that those meters which were set at the depth of the service in a well-constructed vault were the ones to escape injury.

**Methods of Thawing Mains and Services.**—The methods used to thaw mains and services were many and varied, from the pick, shovel, and teakettle to the "natural."

Hot water and steam were used in many cases, but they are manifestly not best suited for conditions which prevailed during the past winter.

The calls for help that went out from the water works fraternity to their brethren of the electrical fraternity resulted in the development of many types of electrical thawing apparatus.

The one best known and most generally used was through the overhead wires of the lighting companies. In this type the high-tension primary wires, carrying 2,200 to 2,400 volts, were tapped and the current carried to cut-out boxes with suitable fuse wires. From the fuse boxes the wire ran to one or more transformers whose capacities ranged from 15 kw. to 75 kw.

In the large majority of cases the voltage was reduced by the transformers to 110, and the amount of current delivered upon the pipe was further controlled by the use of a water rheostat.

The motor-generator set was used to a considerable extent.

One outfit consisted of a 25-volt, 250-ampere, direct-current generator, equipped with a volt-meter, an ammeter and an automatic circuit breaker, mounted on a Ford truck. On the truck was also mounted a countershaft carrying a sprocket wheel at each end, and a driving pulley which was connected to the generator by means of a leather belt. On each side of the jackshaft of the truck was attached a new sprocket wheel just outside of the existing driving sprockets. Upon arrival at the point where the work was to be done, the chains were taken off the driving sprockets and attached to the new sprockets at the jackshaft and to those on the countershaft mounted on the truck. The Ford engine was thus utilized to generate the required current.

The storage battery was used to a limited extent.

One outfit consisted of three trays, each containing eight 2-volt cells, so connected up that a voltage of 16, 32 or 48 could be obtained. Another of six trays of four 2-volt cells each was still more flexible, as voltages of 8, 16, 24, 30, 36, and 42 were possible.

Another of six trays of three 2-volt cells were connected in multiple series, giving a voltage of 35. This outfit proved unsatisfactory, as serious damage was done to the pipes in a number of cases.

The properly connected storage battery has proved very efficient. Like the motor-generator set, it is flexible and portable, and, when operated by an experienced man, it is a safe method. If improperly used, damage to the pipes and to the battery itself can easily result.

The batteries must be recharged after a continuous day's use, the operation taking eight hours' time.

The storage battery is delicately constructed, and can be easily damaged, both in discharging and in recharging. It deteriorates when not in use, especially during the long period of the year when it is not needed.

To reduce the probability of damage to a minimum, an experienced man should be in charge of the work, instruments to determine both voltage and amperage should be used, reasonable time should be taken for the actual work of thawing, and under no conditions should a larger current be used than experience has shown to be reasonable under similar conditions.

While available data are to some extent conflicting, and more exact information is desirable, yet general experience shows that, for the work of thawing ⅝-in. lead or ¾-in. iron service pipes of average length, using 4/0 wire for leads, and with good connections, the following data may be considered as approximately normal:

| | |
|---|---|
| Drop in pipe | [illegible] volts |
| Total voltage required | [illegible] volts |
| Amperes required | [illegible] |
| Time required to thaw | [illegible] |

With larger pipes, or with pipes longer than the average, of course more electrical energy and time is required.

For all-round, efficient, economical work, the committee looks most favorably upon the motor-generator set. It is flexible, can go where the work is to be done, can work continuously, does not deteriorate when not in use, can be made almost fool-proof, and, if properly designed, is the safest type of apparatus from the point of view of danger to the water pipes.

**Cost of Laying Water Mains at Hartford, Conn.**—The accompanying tabulation from the annual report of the Board of Water Commissioners of Hartford, Conn., for the year ending March 31, 1917, gives the cost of laying water mains in 1916 in that city:

HARTFORD.

| [illegible] | [illegible] | [illegible] | Material. | Trans-[illegible] | Total |
|---|---|---|---|---|---|
| [illegible] | [illegible] | $[illegible] | $0.52 | [illegible] | [illegible] |
| 6 | [illegible] | 0.52 | 0.87 | [illegible] | [illegible] |
| 8 | [illegible] | [illegible] | 1.12 | [illegible] | [illegible] |
| [illegible] | 1,040 | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | 1.80 | [illegible] | [illegible] |
| 16 | [illegible] | [illegible] | 2.48 | [illegible] | [illegible] |
| 24 | [illegible] | [illegible] | 3.71 | [illegible] | [illegible] |
| WEST HARTFORD. | | | | | |
| [illegible] | [illegible] | [illegible] | 0.82 | [illegible] | [illegible] |
| [illegible] | 10,512 | 0.52 | [illegible] | 0.01 | 1.64 |
| [illegible] | [illegible] | [illegible] | 1.05 | 0.05 | [illegible] |

[illegible] ing 120 ft. of 20-in.

[illegible]

The costs do not include overhead charges. They are based on labor at $2.50 per 8 hours; pipe at $31 per ton; specials at [illegible] per ton, and lead at [illegible] per pound.

# Regulating and Measuring Chambers for Intercepting Sewers of Essex Border Municipalities

A contract was let last August for the construction of the first section of the intercepting sewer which forms a part of the sewage disposal project of a group of cities on the Canadian side of the Detroit River opposite Detroit, Mich. This interceptor will serve the municipalities of Ford City, Walkerville and Windsor to Parent Ave., in the latter city. The sewage will flow by gravity through Ford City and Walkerville to a pumping station whence it will be lifted to a high level interceptor through which it will flow by gravity to Parent Ave.

Regulating chambers are provided at points where the outlet sewers of Walkerville cross the interceptor. These chambers divert the dry weather flow, plus the storm water allowance, into the interceptor. Measuring chambers, to determine the actual sewage flow from the several municipalities are provided for at the dividing lines between Ford City and Walkerville and Walkerville and Windsor.

**Measuring Chambers.**—A system by which sewage flow could be measured accurately was necessary, not only to properly apportion annual charges to the several municipalities, but also to fix the responsibility in case of future overcharging of sewers and consequent need of further extensions.

It was considered more satisfactory to measure the sewage where the interceptor crosses the municipal boundaries rather than to attempt to measure the flow from each inlet to interceptor.

A reduced number of meters was advantageous because meters would require constant attention to keep in condition and give reliable data, and the reduction in number would allow use of more expensive and accurate measuring apparatus. From the standpoint of accuracy and economical consideration Venturi meters were considered as giving the most satisfactory results. Venturi meters eliminate most of the objection of loss of head which in case of weirs would be rather serious, as each drop at a weir would entail deepening the entire length of sewer below the weir.

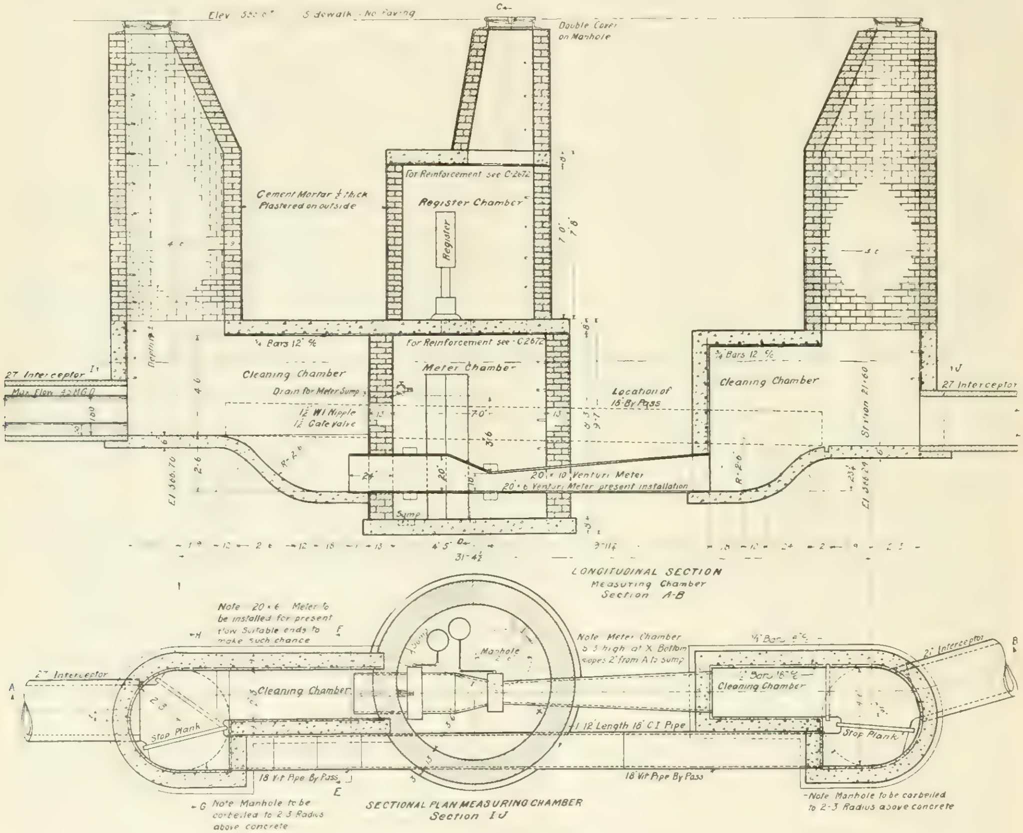

Fig. 1.—Plan and Section of Ford City Measuring Chamber, East Sewage Interceptor.

Figure 1 shows in detail the arrangement of the Ford City sewage measuring chamber. In the design of this chamber provision was made for change in meter from a 20-in. x 6-in. to a 20-in. x 10-in. meter.

The Ford City measuring chamber is located at a point tween Ford City and Walkerville. It consists of a cleaning chamber through which the sewage flows before it enters the Venturi tube which is located in a circular brick chamber, above which are a register chamber and manhole. After the sewage flows through the meter it passes through a cleaning chamber and manhole to the other end of the interceptor.

A by-pass pipe is located along the chamber to divert the flow directly into the lower cleaning chamber. Stop planks are provided at both ends to operate the by-pass pipe.

The Walkerville measuring chamber is located at the

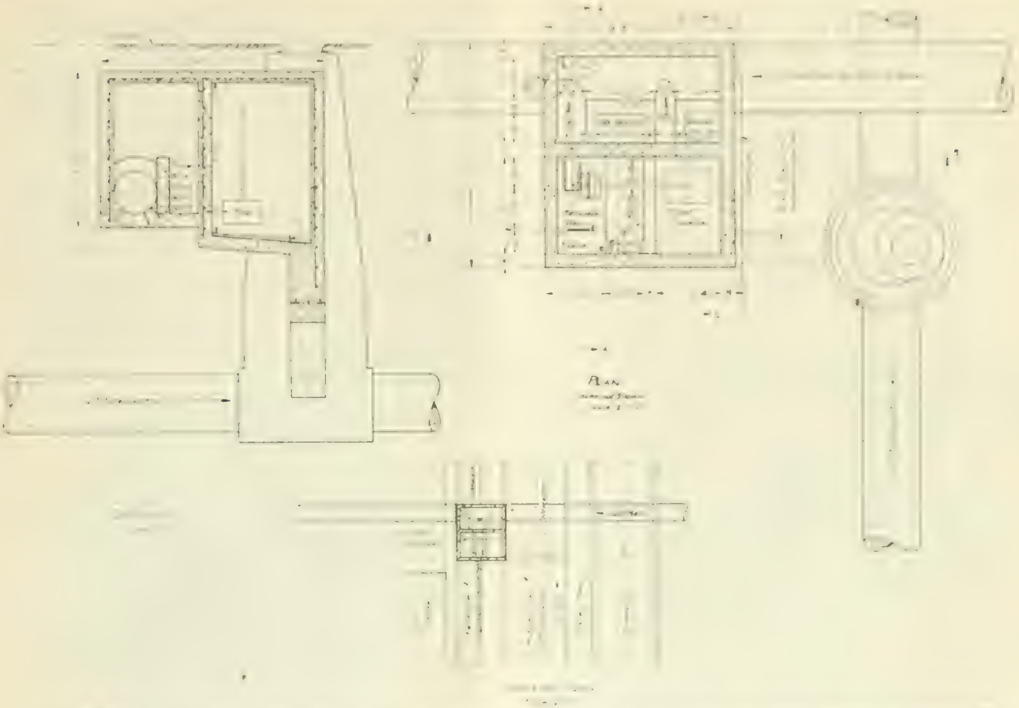

Fig. 2—Plan and Sections of East Main Regulating Chamber, East Sewage Interceptor, Essex Border Utilities Commission

lower end of the West Main Pumping Station about 900 ft. where the interceptor crosses the municipal boundary beeast of the municipal boundary between Walkerville and Windsor. It consists of a circular brick chamber covered with a concrete slab and manhole above.

**Regulating Chambers.**—In designing the work, the engineers, Morris Knowles, Inc., Pittsburgh, Pa., devoted a considerable amount of study to determine the best suitable type of regulator to be adopted. Many studies were prepared with different types of mechanical apparatus, and finally the choice of regulator was made from three designs that had met successfully all important objections to other types. Figs 2 and 3 show in detail the main features of the type of regulator adopted.

The regulator consists of a float in a float chamber directly connected to the intercepting sewer. Two perpen-

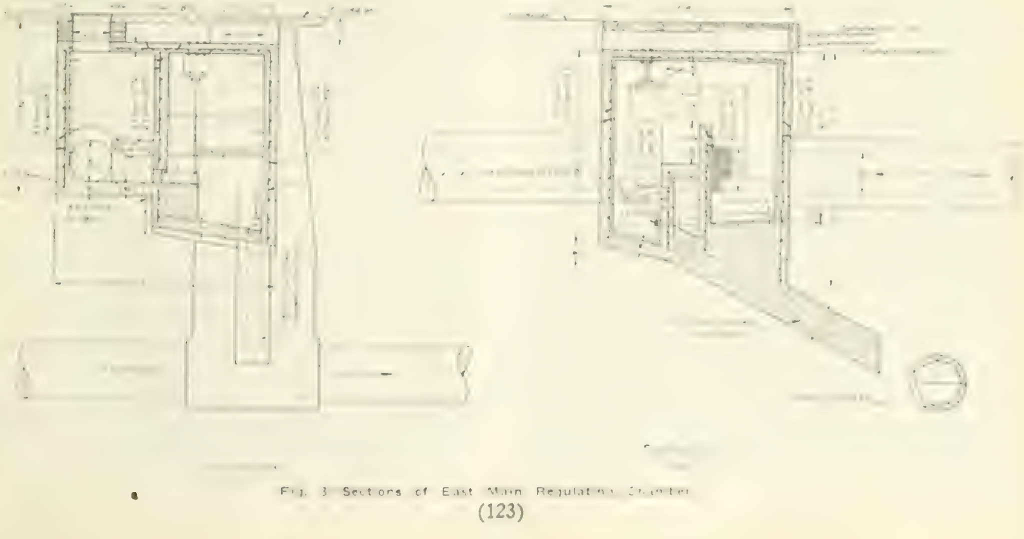

Fig. 3—Sections of East Main Regulating Chamber

dicular and one horizontal bars form the connection between the float and a float operated gate in a gate chamber at the end of an opening designed to take the dry weather flow plus the storm water allowance.

The float being directly connected with the intercepted sewer, as shown in section B-B, Fig. 3, is actuated by the elevation of sewage in the sewer and thus opens and closes the gate to discharge the desired quantity through the gate area. The ranges in the rise of float and gate were calculated and the point of support, which is adjustable, for the horizontal bar was determined to accommodate these changes.

A screen is provided between the float chamber and the sewer to avoid deposits in the chamber. A 3-in. pipe drain with a valve at the lower end connects the float chamber to the gate chamber to permit drainage of the float chamber.

The sewage flows through the gate and before it goes to the interceptor it passes through a removable weir at the lower end of the gate chamber and thence through an outlet to a manhole and interceptor.

A stop plank at the gate entrance and a by-pass outlet are provided in case the apparatus has to be cleaned, removed or repaired.

A dam of sufficient height at the lower end of the intercepted sewer in the chamber diverts the dry weather flow into the regulating chamber.

Economy of construction, simplicity of arrangement, desirability of continuity of operation, and the fact that this type does not depend on an orifice for its successful operation, dictated its choice. This type has the added advantage that the gate is regulated by one float which is directly connected to the sewer to be intercepted.

The information given above is abstracted from a paper presented at the last annual convention of the American Socity for Municipal Improvements by Morris Knowles and John M. Rice.

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**Supervisors Aid Garden Work.**—Two cents per capita was all it cost to conduct the garden work last season in seven Indiana cities in which assistant county agents were placed. This amount paid for the supervision and office work connected with the gardening campaign and for the plowing, etc. In the seven cities there were 129,000 gardens that produced products valued at $1,550,000, the total cost being $11,933. Although the increase in total number of gardens in the state over the previous year amounted to 28 per cent, the estimated increase in the seven cities was about 60 per cent, which, it is believed, demonstrates the value of proper supervision. In none of the cities in Indiana were the gardens kept in better condition and the production of vegetables per garden greater than in the cities in which the assistant county agents operated. In several other cities the average gardens were just as good, but these communities also employed good garden supervisors. A total of 150 supervisors were employed in 102 cities and towns in the state. In addition to this number the garden work in 65 cities and towns was supervised by garden committees.

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**Cost of Garbage Reduction.**—In a paper prepared for the 21st annual convention of the League of California Municipalities, W. T. Knowlton, Engineer of Sewers of Los Angeles, states that it is estimated that the cost of constructing a plant for the disposal of garbage by reduction averages $287 per daily ton capacity. The cost of operation varies from $1.50 to $2.50 per ton of garbage. He states that the revenue obtained in three reduction plants in Ohio shows an average of $1.32 per ton. The following figures are for the Columbus plant: This plant treats about 22,000 tons per year, the population tributary being 215,000 and the garbage per capita, per year, being 203.3 lb. In 1915 the cost of operation per ton of garbage was $1.94, and the earnings were $2.42, leaving a revenue of 48 ct. per ton. In 1916 the cost of operation was $2.22, the earnings $4.05, and the revenue was $1.83. The Columbus garbage yielded 3.08 per cent of grease, worth 5 ct. per pound or $3.18 per ton of garbage; also 10.3 per cent of tanking worth $8 per ton of tankage, or 81 ct. per ton of garbage.

# Economic Pressure Pipe on Penstock Pipe Design

It is a well known fact that the most economical penstock for a given plant is one where the diameter decreases as the thickness of plate increases, i. e., as the head increases. Prof. Melvin L. Enger (Engineering Record, Sept., 1914) and Prof. E. W. Rettger (Engineering Record, Oct., 1914) have given formulas connecting the diameter and thickness of plate with the profile of the penstock. In the November Journal of Electricity Mr. B. F. Jacobsen, consulting electrical engineer of Berkeley, Cal., gives a method of design that avoids mathematical complications. The article is reprinted below:

**Theoretical Assumptions.**—We may consider the head and the amount of water as given. If the penstock is very small, the annual charge for the penstock will also be very small, but practically the entire available power will be absorbed as friction head. If the penstock is enlarged progressively, more and more power will be made available at the power house and it will be found that the annual charge per horsepower gained in this manner will increase progressively with the penstock and therefore there is a certain limit for each part of the penstock beyond which it is uneconomical to go, since further enlargement will entail a larger additional charge than the power gained is worth. (See Fig. 1.)

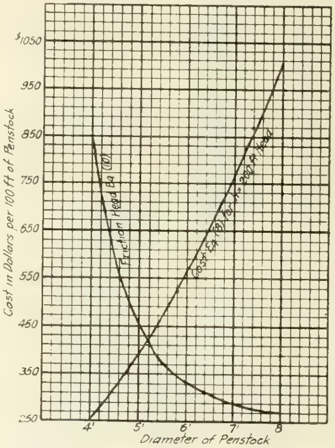

Fig. 1—With an increased size for the penstock more power is available at the power house, but the annual charge per hp. gained also increases progressively with the penstock, thus fixing a limit beyond which it is uneconomical to go.

When considering this subject, it may be assumed that the amount of money available for the penstock has been approximately determined from the friction head and the general conditions of the entire power system, and it is required to design a penstock to fit the given profile, and such that either:

(1) With a given cost, the friction head is to be a minimum, or

(2) With a given friction head, the cost is to be a minimum.

Assume a penstock already installed; this is to be checked over to see whether or not the design is economically correct. The penstock is to be considered by itself and apart from the rest of the plant; we merely check one section of the penstock against another section.

Let c be the annual cost in dollars of one foot of the penstock at a point where the head is h feet. This annual charge would be found from the cost of this one foot of penstock multiplied by a percentage figure i which covers interest, depreciation, maintenance, taxes, insurance, etc. Let $h_f$ be the friction head for this one foot of penstock. Also, let c' and $h'_f$ be the corresponding values for a penstock slightly larger in diameter and correspondingly thicker, since the stress on the steel is to be the same.

If this larger penstock had been used, there would have been a gain in power since the friction head would be less, but the larger pipe would also have cost more. The gain in power would be proportional to the reduction in friction head and this would be $h_f - h'_f$; while the additional annual charge would be $c' - c$. The annual cost of this gain in head would therefore be

$$k = \frac{c' - c}{h_f - h'_f} = \frac{\Delta c}{\Delta h_f} \quad \ldots\ldots(1)$$

where $\Delta h_f$ is the reduction in friction head and $\Delta c$ the annual charge which this would entail. The power lost is proportional to the friction head, since the same amount of water flows through each section of penstock, but we need not be concerned with the power loss when comparing one section of a penstock with another section of the same penstock.

Values for k may now be determined for the various sections of the penstock, as per equation (1). Suppose it was found that the values $k_1$ and $k_2$ for two different points along the penstock were such, that $k_1$ was larger than $k_2$, then it would evidently pay to decrease the diameter at point 1 and increase it at point 2 and it would pay to continue this until $k_1 = k_2$. The criterion for maximum economy in design is therefore, for all sections of the penstock:

$$\frac{\Delta c}{\Delta h_f} = k = \text{constant} \quad \ldots\ldots(2)$$

When designing a new penstock, we would start by selecting the diameter and the thickness of the penstock at one point; from this k could be determined. Then with this value for k the other sections could be determined and by adding all these up, the total annual cost and the total friction head would be determined. If the cost was found to be too high, all sections would have to be proportionately reduced, and vice versa.

The annual power loss due to the friction head and measured at the substation switchboard, is:

$L = 995\ q\ e\ h_f$ hp. hr. ....(3)

when:

$q$ = the average annual flow in sec. ft. and

$e$ = the average annual efficiency from end of penstock to substation switchboard.

The gain of power resulting from a reduction of friction head from $h_f$ to $h'_f$ is therefore:

$$\Delta L = 995\ q\ e\ (h_f - h'_f)$$
$$= 995\ q\ e\ \Delta h_f \text{ hp. hr.} \quad \ldots\ldots(4)$$

Since q and e are constants:

$$\frac{\Delta c}{\Delta L} = K = \text{constant} \quad \ldots\ldots(5)$$

Where:

$K = k/995\ q\ e$ ....(6)

K in equation (5) is an economic index, since it denotes what the cost is for the last increment of power obtained by making the penstock the size it is instead of slightly smaller. It follows therefore that K should be less than the price of power at the substation minus the cost of production from the end of the penstock to the substation switchboard. If K is larger than this value, the power gained by making the penstock larger than its economical size costs more than it brings. It may not always be possible to keep K below its economical limiting value for every part of the water conduit or of the system, since operating conditions may impose other

**A Numerical Illustration.**—To illustrate the above, let the cost of a steel penstock be assumed proportional to the diameter and the thickness, and let:

R = radius of penstock in feet;

t = thickness of plate in inches;

w = weight in lbs. per foot of penstock.

Add 20% for riveted joints, then

$w = 1.2 \times 40 \times t \times 2\pi R = 302\ R\ t$ lbs.

Let

p = price in dollars per lb. of penstock installed;

i = annual percentage charge covering interest, maintenance, depreciation, taxes, etc.

The annual charge per foot of penstock is then:

$c = w\ p\ i = 302\ R\ t\ p\ i$ dollars ....(7)

If

h = head in feet acting on penstock;

s = allowable stress in lbs. per sq. in.; then

$t = 5.2\ h\ R/s$ inches ....(8)

From (7) and (8) follow:

$c = 1570\ i\ p\ h\ R^2/s$ dollars ....(9)

Let

$h_f$ = friction head in feet per foot of penstock;

q = flow in cubic feet per second;

v = velocity of flow in feet per second.

Let the friction head be expressed by:

$$h_f = \frac{0.0254\ v^{1.85}}{(2R)^{1.127}\ 64.4} \text{ ft.}$$

It is:

$q = v \times R^2\pi$

Eliminating v from above expression for $h_f$ we get:

$$h_f = 0.0000217\ \frac{q^{1.85}}{R^{4.927}} \text{ ft.} \quad \ldots\ldots(10)$$

The values for $\Delta c$ and $\Delta h_f$ may be found from equations (9) and (10) by substituting a slightly larger value than R, say 1.05R and subtracting, exactly as equation (1) was formed, but in this case, they may be more conveniently found by differentiating (9) and (10) with respect to R since h may be considered as a constant; that gives:

$$\Delta c = dc = 3140\ i\ p\ h\ R\ dR/s$$
$$\Delta h_f = dh_f = -0.000105\ q^{1.85}\ dR/R^{5.927} \quad \ldots\ldots(11)$$

$\Delta h_f$ is negative, because the friction head decreases when the diameter increases; neglecting the minus sign:

$$k = \frac{dc}{dh_f} = \frac{3140\ i\ p\ h\ R^{6.927}}{0.000105\ s\ q^{1.85}} \quad \ldots\ldots(12)$$

Eliminating h/s from (12) by equation (8):

$$k = \frac{604\ i\ p\ t\ R^{5.927}}{0.000105\ q^{1.85}} \quad \ldots\ldots(13)$$

and consequently:

$$t = \frac{0.000105\ k\ q^{1.85}}{604\ i\ p\ R^{5.927}} \quad \ldots\ldots(14)$$

Since k is known or is assumed, (14) gives the relation between R and t and the corresponding head may be found from equation (8).

Equations (12), (13) and (14) give the diameter and thickness only for that portion of the penstock where equations (7), (8) and (10) hold good. Near the top of the penstocks equation (8) does not hold good, since the penstock cannot be made less than a certain thickness, no matter how small the head may be at that point. In order to apply equation (1) to the upper section the law expressing the relation between R and t must be known and this will be independent of h until h reaches a large enough value, so that equation (8) applies. The above formulas also imply a constant value for s, but it will not pay to use all the various thicknesses of plate obtainable, and therefore s will vary somewhat.

Equations (7) and (9) are only approximations, since the weight of a riveted pipe of various thicknesses and diameters is not directly proportional to the thickness of plate and the diameter, nor is the cost likely to be directly proportional to the weight. Also equation (8) is only approximately correct, since it is the strength of the joint that will control the amount of head that may be safely used. Therefore, when applying equation (1) to an actual penstock, k should be determined from the estimates, bids, etc., for each size in question, and equations such as those from (7) to (14) can only be approximations.

If q varies considerably during the year, as for instance between $q_1$ and $q_2$ where $q_2 > q_1$, the value to be used for q is not 0.5 $(q_1 + q_2)$ even where the variation between q and time may be so arranged as to give practically a straight line when plotted, but the value for q must be found from:

q = [illegible]

If $q_1$ = 200 and $q_2$ = [illegible] this would give q = [illegible]

If a straight line relation does not exist between q and time, the general formula:

[illegible]

$$q' = \frac{t_1 \times q_1^{1.85} - t_2 \times q_2^{1.85} + t_3 \times q_3^{1.85} + \ldots\ldots\ldots\ldots\text{etc.}}{8760}$$

must be used. $t_1$, $t_2$, $t_3$, etc., are the hours per year during which the flow is $q_1$, $q_2$, $q_3$, etc."

Example: A penstock for a head of 1,000 ft. is to be designed: let it be assumed provisionally that at the top, where h = 0 the diameter is to be 6 ft. and the thickness ¼ in. and let p = \$0.15, i = 0.16, q = 300 and as stated R = 3′ and t = 0.25″. Substituting these values in (13) gives k = 548 and then from (14) is obtained:

$t = 151\ R$ [illegible]

This will give the correct value of R for any value of t and from (8) with s = 12,000 lb. per sq. in. the corresponding value of h may be found. This gives:

| Thickness. | Radius. | Head. |
|---|---|---|
| 0.25″ | 3.00′ | 192′ |
| 0.5 ″ | 2.67′ | 449′ |
| 0.75″ | 2.48′ | 698′ |
| 1.00″ | 2.36′ | 978′ |

The variation of penstock diameter with the head is shown in Fig. 2, on the assumption that the thickness of plate varies continuously as the head and the diameter.

In this manner the head and diameter corresponding to each thickness may be determined and the most economical penstock proportions for that particular profile may be determined. If this is found to cost too much, k must be reduced by assuming a smaller diameter at the top and the proportions and total cost determined again. It will not generally pay to use many different thicknesses of plate or too many different diameters; calculations only can show how far it will pay to go in each case.

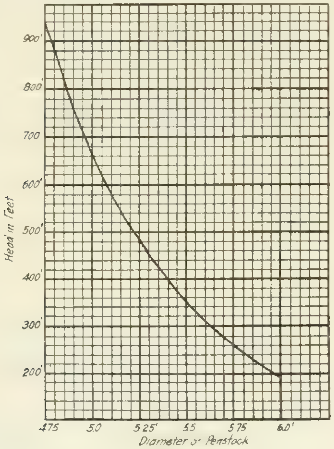

Fig. 2—The variation of penstock diameter with the head. This is based on the assumption that the thickness of plate varies continuously as the head and diameter.

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**Rates of Use of Water by Plumbing Fixtures.**—The following table, from a paper presented at the November meeting of the New England Water Works Association by Caleb Mills Saville, Chief Engineer of the Water Commission of Hartford, Conn., shows the rates of use of water in the operation of various fixtures actually observed in a recent investigation in that city:

| | Rate of use cu. ft. per minute. |
|---|---|
| Flushing closets— | |
| Operating singly | 4.5 |
| Three operated in quick succession | 10.0 |
| Shower baths— | |
| 10 continuously | 6.0 |
| 5 continuously | 4.0 |
| 10 continuously and four flushometer closets operated in quick succession | 12.0 |
| Urinals—22 operated in quick succession by two persons | 5.0 |
| Hydraulic lift at Hartford-Aetna National Bank | 18.0 |
| Hydraulic lift at Pilgard Market | 20.0 |
| 6-in. plunger hydraulic elevator | 30.0 |
| Washing machines— | |
| Filling 2 150-shirt machines | 30.0 |
| Filling 1 large machine | 17.0 |
| Loomis and Manning filter at Hartford-Aetna National Bank | 12.0 |
| Filters at Alfred E. Burr School, limit of capacity | 23.0 |
| Washing filters | 10.0 |

# Status of the Hetch Hetchy Water Supply Project of San Francisco

On Jan. 4, 1910, the citizens of San Francisco, Cal., voted \$45,000,000 for obtaining a mountain water supply from sources including Lake Eleanor and waters of Tuolumne River and vicinity. The total quantity of water to be ultimately diverted from the Tuolumne River for the supply of the San Francisco and East Bay Metropolitan District is 400,000,000 gal. daily, of which approximately half will go to San Francisco and the balance to East Bay cities, to San Jose, and the small communities in the district. It is intended that one-third of this total shall be made available in the initial development.

The works necessary to provide 133,000,000 gal. daily delivery to the Metropolitan District and 67,000,000 gal. daily delivery to San Francisco are as follows:

1. Low dam at Hetch Hetchy.

2. Nineteen miles of 400,000,000-gal. daily capacity pressure aqueduct, 10 ft. 3 in. in diameter, with 8 ft. fall per mile, from a point at Early Intake, 12 miles below Hetch Hetchy, to Priest reservoir, where a power drop of 1,300 ft. would create 66,000 mechanical horsepower.

3. Power drop to Moccasin Creek.

4. Seventeen and one-half miles of 400,000,000 gal. daily capacity aqueduct tunnel, 10 ft. 3 in. diameter, from Moccasin Creek to east side San Joaquin Valley.

5. Forty-five miles of 6 ft. 10-in. diameter steel pipe across San Joaquin Valley, 133,000,000 gal. daily capacity.

6. Thirty-one and one-half miles of 10-ft. tunnel through Diablo range to Irvington, 200,000,000 gal. daily capacity.

7. Thirty-one and one-half, miles of pipe 6 ft. 4 in. in diameter, capacity 67,000,000 gal. daily, and 20½ miles of tunnel, 200,000,000 gal. daily capacity, to San Francisco, making a total length of 156 miles.

The status of the project is outlined as follows in a report issued Aug. 31:

A railroad 68 miles long has been built from Hetch Hetchy Junction, on the Sierra Railway, 26 miles northeast of Oakdale, to Hetch Hetchy Damsite, at a cost of approximately \$2,000,000. This is a standard-gage railway with 60-lb. rails, capable of handling all freight on the work and bringing return freight of very nearly 2,000,000 tons of lumber, which is tributary to the road.

A 4,000-HP. hydro-electric power plant has been completed at Early Intake, 12 miles below Hetch Hetchy, which provides electricity for all the construction operations in the mountains.

A buttressed arch dam at Lake Eleanor, 64 ft. high and 1,200 ft. long has been constructed across the gorge one mile below the lake, which now has a capacity of double the size of Lake Chabot.

A power canal in tunnel aqueduct and in flume, 3 miles long, has been built from Cherry River to the power plant. This canal is fed in low periods of water flow by the released water from Lake Eleanor.

A power line has been built from Early Intake to Priest, a length of about 20 miles, and electricity is now conducted into all of the larger headings of the tunnel aqueduct, for lighting and construction use.

The main tunnel aqueduct has been started from Early Intake to Priest. Work is now proceeding (August) in three shifts on those portions of the work which will take the longest time to complete. This tunnel aqueduct will be 10 ft. 3 in. in diameter, lined smoothly with concrete, capable of carrying 400,000,000 gal. of water per day.

Explorations and preparations have been made for construction of a large dam at Hetch Hetchy, and a low forebay dam at Priest, which will carry three days' flow of the aqueduct, thereby increasing the flexibility of the power plant, and a draft as high as 100,000 HP. can be drawn at peak periods from the first large unit. The Hetch Hetchy dam will be 320 ft. above the water surface in the stream, and an average of 65 ft. below. A magnificent grade of granite bedrock exists on both walls of the canyon, and also in the underlying formation, which has been tested by diamond drill borings. The Hetch Hetchy dam will store 112,000,000 gal. of water, or five times the capacity of Crystal Springs Lake, over a territory covering nearly 1,[illegible] acres. A future larger dam at Lake Eleanor will be able to store 93,000,000 gal. of water in a reservoir of 1,443 acres.

The entire aqueduct between Priest and San Francisco, passing south of Niles, has been located on the ground with concrete monuments, and maps for procuring right of way are prepared. A connection with the transbay cities can be made near Niles, a distance of 27 miles from Oakland.

Generally, all the more difficult portions of the work in the inaccessible mountains have been well started, and money may be spent now at the rate of $6,000,000 per year to complete the project. If this is done, water could be delivered to San Francisco inside of six years.

At the present time (August, 1918), due to war and labor conditions, none but the more difficult portions of the work are being proceeded with. With an early and satisfactory determination of the war, operations will be more actively prosecuted. The work is being carried out under the direction of M. M. O'Shaughnessy, City Engineer, of San Francisco.

## How Uncompleted War Contracts Are to Be Liquidated

In the first authoritative announcement of the process of liquidation of uncompleted war contracts made public Dec. 1, Assistant Secretary of War Crowell, director of munitions, explains in detail the adjustment organization and the steps each contractor must take to reach a settlement with the government. The War Department has first to determine as to each of these contracts whether it is to be carried through, whether the rate of amount of production is to be so reduced that the manufacturer can gradually taper off and get into his accustomed civilian work, or whether the contract is to be terminated at once. These questions have to be decided with due regard to the conditions of the particular industry and the importance of preserving the continuous employment of labor. When decided there remains a serious problem of how to arrive at a just and prompt determination of what is due the contractor as a result of such reduction or termination of the contract.

"The contractor," Mr. Crowell said, "will make an inventory of the raw material on hand, work in process, and finished articles ready for delivery, and any other items of costs, with figures on the various elements of cost which have entered into the getting ready for production, such as new buildings and machinery not otherwise taken care of. This will be checked by accountants of the War Department. These statements, in the majority of cases, will then be presented to district boards organized in many of the larger cities which are the centers of production, such as Boston, Bridgeport, New York, Rochester, Philadelphia, Pittsburgh, Cleveland, Chicago, Detroit, St. Louis, etc.

"A board to deal with ordnance contracts at each of these places will be presided over by the district ordnance chief, who in every case is a civilian and a prominent business man of the community, frequently, prior to the war, having been connected with industries along similar lines to those now engaged in war work.

"Another member of the board will generally be the regional adviser of the War Industries Board. Such advisers are prominent business men, often selected for the position by the local chamber of commerce and in intimate touch with the problem of adjustment presented by reason of their experience with the industries in their localities in getting ready for war production.

"Another member will be of legal training, another a cost accountant, and the fifth a man versed in technical production. The latter three members are generally already available on the staff of the ordnance district chief. With a board so constituted the public, the government, and the industries will feel assured that a just and prompt settlement may be arrived at. Boards will also be established for the settlement of contracts for more standard articles of merchandise, such as clothing, leather goods, etc."

## Shall The "Case Method" Be Generally Used in Teaching Engineering?

The Carnegie Foundation for the Advancement of Teaching has just published a bulletin of 140 pages entitled, "A Study of Engineering Education," by Prof. Charles R. Mann. The preface, by Henry S. Pritchett, President of the Carnegie Foundation, admirably summarizes the most important recommendation made by Prof. Mann, namely, that engineering should be taught by Langdell's "case method" which revolutionized the teaching of law. The following is taken from the preface of the bulletin:

Professor Charles R. Mann argues that the present arrangement, under which the fundamental sciences are taught in advance of their applications, is the wrong method of teaching, and that the engineering education will never be satisfactory until theory and practice are taught simultaneously.

For example, mathematics is the most important tool of the engineer. It is taught for two years in the engineering school in separate courses—higher algebra, co-ordinate geometry, the calculus, and mechanics. The splitting up of mathematics into separate courses is itself a source of weakness from the standpoint of the student's needs. He needs not studies nor recitations in these artificial divisions of mathematics, but a single course in mathematics illuminated and made alive at every step by applications in the solutions of actual problems. Algebra, co-ordinate geometry, and the calculus are not separate and unrelated studies, but merely parts of the one subject of mathematics.

As a consequence of this method of teaching Professor Mann urges that the engineering courses, as taught in the preliminary years, do not form sound criteria for judging as to the ability of the student to do successful engineering work, and that many students are sent away from the technical school without having had any fair test as to their capacity for engineering practice or study.

In the third place he gives the results of certain objective tests designed to throw light upon the fitness of the applicant to undertake engineering studies and practice. It is quite clear that the trial of these tests made hitherto is not sufficient to demonstrate their trustworthiness, but the question raised is an exceedingly interesting one. There are few devices connected with teaching more unsatisfactory than our present day examinations, whether used as tests for admission or as criteria of performance on the part of the student.

In general these suggestions of Professor Mann, if carried out, would affect present day teaching of engineering in much the same way that Langdell's case method revolutionized the teaching of law.

Langdell built the teaching of law exclusively and directly upon the study of cases. His notion was that the principles upon which the law rests are few in number, and that these could be best apprehended and mastered by the student in the direct examination of typical cases. The number of such cases necessary to illustrate these principles he held to be very small in comparison with the overwhelming mass of law reports to which the student had formerly been directed as the basis of the study of the law in conjunction with textbooks. Langdell's method involved the working out by the student of the principles of the law from actual cases tried and decided in the courts. Law he conceived of as an applied science.

Langdell's method is not infrequently referred to as the laboratory method of teaching law, conveying the impression that the case method of teaching law consists in transferring to the teaching of law the methods employed in the teaching of applied science. This statement has been the [illegible] case method presents only a remote analogy with the methods hitherto employed in teaching applied science. Applied science is not taught ordinarily in the engineering school by the case method. On the contrary, the methods actually employed in teaching the so-called laboratory subjects do not differ appreciably from the methods of teaching literature or Latin. At present the student undertakes to learn a vast body of theory under the name of physics, mechanics, or chemistry, illustrated in some measure in the laboratory, and then seeks later to select from this mass of knowledge the principles to be applied, for example, in electrical engineering. The case method would proceed in directly the opposite manner. Taking up, for example, the dynamo as a "case" that is, as an illustration of physical laws in their actual complete working—it would proceed to analyze the machine for the purpose of discovering the fundamental, physical or mechanical principles involved in its operation. It would lead the student from practical applications by analysis to a comprehension of theory, instead of from theory to applications is under present methods of teaching.

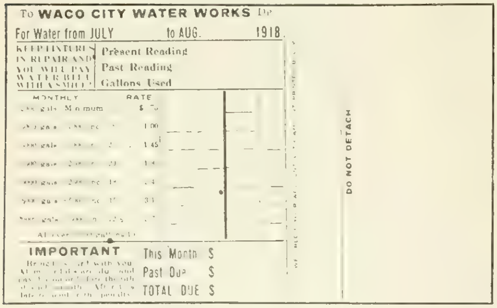
It is an interesting fact that while much is said about the teaching of science in the modern school, the methods of teaching science are actually but little changed from those employed in teaching the subjects that filled the curriculum before the teaching of science began in the school. The practical suggestion of this report is that the case method of teaching is truly scientific and that the present methods of teaching applied science are unscientific. Furthermore, as an essential feature of the new method of teaching science, Professor Mann would combine theory with practice much more intimately than occurs in the law schools of the present day, by requiring the student to learn to operate the "case" under study. The student must not merely observe and analyze the operation of the dynamo: he must also actually run it and repair it when out of order. The method of teaching he advocates for engineering students, while based on the same conceptions as Langdell's pedagogic innovation, is designed to meet some of the objections commonly raised today against even case method law schools.

Whatever may be thought of this contention, the subject is one of great significance, and worthy of the attention of teachers and engineers. Engineering schools, like all institutions of learning, are slow to undertake educational experiments. It is sometimes easier to start a new school than to try an educational experiment in an old one. But obviously an actual experiment thoroughly carried out would be the only satisfactory demonstration of the soundness of the case method of teaching science.

Prof. Mann's report is published by the Carnegie Foundation as a work of co-operation with the great engineering societies, and with the hope that the formulation of these important inquiries and their discussion may lead to a serious effort on the part of those having to do with engineering education to re-examine the curricula of the schools, and to approach the problem of their improvement not only from the standpoint of the teacher, but also from that of the practicing engineer and of the employer.

## Postal Card Water Bill

The municipal water works of Waco, Tex., sends out its monthly bills to metered consumers on postal cards. The form used is shown in the accompanying cut. The card is returned by the consumer with his remittance. It is then run through a machine which cuts off the part showing the date of payment and the number of the account. This number appears on the body of the card, and on the stub. The body of the card is stamped paid and returned to the consumer as his receipt. The stub is retained by the Water Department.



To **WACO CITY WATER WORKS** Dr

For Water from JULY to AUG. 1918

KEEP FIXTURES IN REPAIR AND YOU WILL PAY WATER BILL WITH A SMILE

Present Reading

Past Reading

Gallons Used

MONTHLY RATE

**IMPORTANT**

This Month $

Past Due $

TOTAL DUE $

DO NOT DETACH

Postal Card Bill of Waco, Tex., water Works.

**Utah College to Have Course in Irrigation Management.**—A two weeks' intensive course in irrigation management for water masters will open Feb. 10 at the Utah Agricultural College, Logan, Utah.

# Control of Algae in Irrigation Canals by Copper Sulphate

Copper sulphate, reports Project Manager R. K. Tiffany of the Yakima Project, in the November Reclamation Record, has proved on the Tieton Main Canal an effective remedy for the algæ growth which for the past several seasons has infested the open concrete-lined sections.

The Tieton Canal is about 12 miles long, over 2 miles of which is tunnel. Most of the remainder is lined with precast reinforced concrete segmental shapes having an inside radius of 4 ft. 1 13/16 in. and a clear depth of 5 ft. 10 in. The designed capacity when clean was 326 second-feet, with a freeboard of 7 in., based on a value of Kutter's $n = .012$.

It was found after putting the canal into service that an algæ growth was appearing which produced an obstructing effect upon the flow much in excess of the actual sectional area occupied by the growth. These algæ in appearance were fine, pale green, hairlike growths, reaching a length of almost 2 in., and were attached to the sides of the canal at the water surface in a strip about 3 in. wide. Each season they became seeded in the concrete at the successive water marks, appearing as a series of green horizontal bands when the water was turned out of the canal. The growth is dependent to some extent upon the temperature of the water, being less rank in years when the season opens late, after a winter of exceptionally heavy snowfall, causing the water to be colder than usual. Light is necessary for the growth of the species, as none is found in the tunnels.

Turning the water out of the canal for a few days proved a palliative measure, the growth drying up and, when the water was turned in again, scaling off and improving the flow conditions somewhat for a time. The growth soon started again, however, and the general effect was to raise the value of Kutter's n from 0.12 to .014.

About July 1 of the present year the growth again became sufficient to retard the flow in the canal. Copper sulphate to the amount of 200 lb. was suspended in burlap sacks in the water near the head of the canal, the entire quantity being dissolved in three or four hours. A week later, when the canal was again inspected, the growth of algæ had entirely disappeared along the water line, where it had been most abundant. It was not feasible to empty the canal, but apparently the entire growth has been destroyed.

The canal was carrying at the time of the experiment about 305 second-feet. The velocity in the open channel where the copper sulphate was suspended, is about 3½ ft. per second, and in the concrete-lined canal about 10 ft. per second.

Copper sulphate has previously been used for the control of algæ growth in municipal reservoirs with satisfactory results, but the strength of solution there used has been about what would have been attained in the Tieton Canal had the quantity used been dissolved in 24 hours. As noted above, it was actually all dissolved in 3 or 4 hours, so that the strength of the solution used was 6 to 8 times greater than the practice has been in reservoirs used for city water supply.

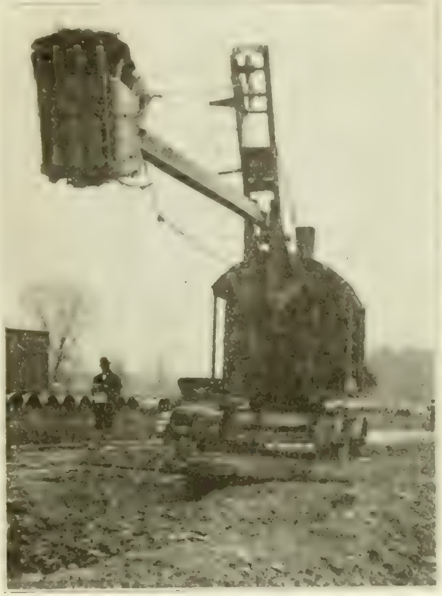
No deleterious effects were noted upon vegetation supplied with water thus treated nor has any other difficulty developed from the presence of the copper in the water. Experiments were recently made with the copper sulphate in earth canals on the Sunnyside unit, using about the same concentration as that used on the Tieton, but, so far, without securing the desired effect. Experiments will be continued with more concentrated solutions, however.

**Increases in Water Rates.**—The Public Service Commission of West Virginia, on Nov. 21, authorized the West Virginia Water and Electric Co. to increase its water rates in the city of Charleston 20 per cent to domestic consumers and an increase on city hydrants from $30 annually to $50 for each hydrant. The order becomes effective Dec. 1 and will extend to July 1, 1919. The City Commission of Middletown, O., on Nov. 29, voted to increase water rates to $1.25 per 1,000 cu. ft. for 1,000 to 5,000 cu. ft. consumers.

# Trenching and Backfilling with Steam Shovel

In constructing a $90,000 [illegible] sewer in Riverside Drive in Lakewood, a suburb of Cleveland, O., a steam shovel was employed for the trenching and backfilling. The sewer is 7,000 ft. long and consists of two lines, one directly above the other. At the outlet the lower line is 24 in. vitrified clay pipe and the upper 27 in. Where connection is made with the existing sewer system this lower line is 18 in. and the upper 24 in.

The trench is 3 ft. wide by 15 ft. deep. Starting at the outlet the top 1½ ft. is hard, baked clay, and the underlying 13½ ft. solid shale, which required three blasts of dynamite to loosen for digging. At the upper end there was 9 ft. of clay and 6 ft. of shale.



Thew Shovel With 30-ft. Dipper Stick on Sewer Construction at Lakewood, Ohio.

To cut this trench the contractors, Randall & Cooper, of Lorain, O., used a Type A1 Thew shovel equipped with a 30-ft. dipper stick. Working 5 hours daily, this shovel averaged 50 lin. ft. of trench, or 83 cu. yd. The length of the dipper stick permitted casting the surplus excavation over the river bank.

Pipe is laid by sections. The shovel digs a certain amount of trench, then the layers follow with the pipe. The shovel backfills the trench with dirt taken from the front.

# Cost of Garbage Collection and Reduction at Cleveland, O.

The cost of collecting and reducing garbage last year at Cleveland, O., increased materially, according to the 1917 report of F. L. Stockberger, Engineer of Reduction.

The amount of garbage collected and reduced during 1917 was 56,121 tons, which is a decrease of [illegible] tons in comparison with the year 1916. The amount of finished material produced from this garbage was 3,071,022 lb. of grease and 6,241 tons of tankage. This is a decrease of 796 tons of tankage and of 748,303 lb. of grease. The decrease, states the report, was caused by the decrease in the quantity of green garbage collected, the high price of all foodstuffs and by the conservation movement which was in vogue during the greater part of the year.

The cost of collection was as follows:

| [illegible] | Amount | Per ton Green Garbage |
|---|---|---|
| [illegible] | | |
| [illegible] | [illegible] | $2.7988 |
| [illegible] | [illegible] | .0742 |
| Supplies | | |
| [illegible] | [illegible] | .0267 |
| [illegible] | [illegible] | .0026 |
| [illegible] | [illegible] | .0272 |
| [illegible] | 25,430 | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | 2,468 | [illegible] |
| [illegible] | [illegible] | .0024 |
| [illegible] | [illegible] | [illegible] |
| Other miscellaneous | [illegible] | .0025 |
| Miscellaneous Expense | | |
| [illegible] | | |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | 1,919 | .0342 |
| [illegible] | | .0001 |
| [illegible] | [illegible] | .2208 |
| Other miscellaneous | 12 | .0002 |
| Total operating cost | [illegible] | $3.7189 |
| Maintenance: | | |
| Cars and wagons—labor | [illegible] | [illegible] |
| Cars and wagons—material | 3,226 | [illegible] |
| Harness—labor | 1,249 | .0223 |
| Harness—material | [illegible] | [illegible] |
| [illegible] | [illegible] | .0324 |
| Other [illegible] | 2 | |
| Machinery, tools and equipment | 299 | .0053 |
| Motor vehicles | 839 | .015 |
| Other [illegible] | [illegible] | [illegible] |
| | $ 15,309 | [illegible] |
| Total collection cost | [illegible] | 4.024 |
| Loss on horses .... | 1,211 | .0216 |
| Depreciation | [illegible] | .1599 |
| Total cost, including depreciation | [illegible] | $4.2[illegible] |

The cost of reduction per ton of green garbage handled was as follows:

| | Amount | Per ton. |
|---|---|---|
| [illegible] | $[illegible] | $0.0395 |
| Clerk hire | 2,100 | .0346 |
| Operation. | | |
| Labor reduction | 77,545 | 1.3818 |
| Supplies | | |
| Office | [illegible] | .0020 |
| Fuel—coal ............ | 50,716 | .9037 |
| Fuel gas | 6,952 | .1239 |
| Miscellaneous light | [illegible] | .0079 |
| Mechanical | [illegible] | [illegible] |
| Cleaning and toilet | [illegible] | |
| Gasoline | 7,323 | .1305 |
| Other miscellaneous | [illegible] | .0022 |
| [illegible] water | [illegible] | .0149 |
| Lake water | 1,752 | .0312 |
| Miscellaneous expense | | |
| Transportation employees | 75 | .0011 |
| Telephone and telegraph | [illegible] | [illegible] |
| Insurance | 217 | .0039 |
| Taxes and rents .... | 1,440 | .0257 |
| Freight | 1 | [illegible] |
| Other miscellaneous | [illegible] | .0165 |
| Total operating cost | $150,426 | $2.6810 |
| Maintenance: | | |
| Machinery and equipment labor | $ 11,213 | $0.2000 |
| Machinery and equipment material | 12,024 | .2142 |
| Building material | 525 | .0093 |
| Total maintenance cost | [illegible] | $0.4235 |
| Total reduction cost | $178,727 | $3.1846 |
| Depreciation | [illegible] | .2187 |
| Total reduction cost, including depreciation. | $191,001 | $3.4033 |

The earnings of the garbage reduction plant amounted to $292,745, of which $232,656 was from the sale of garbage grease and $59,074 was from the sales of tankage.

The following is a comparative statement of the cost of collection and reduction for the years 1913-1917:

| | 1913. | 1914. | 1915. | 1916 | 1917. |
|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 3,283,116 | 3,290,105 | 3,731,770 | 3,819,325 | 3,071,022 |
| | 1913. | 1914. | 1915. | 1916 | 1917. |
| | Per ton. | Per ton. | Per ton. | Per ton | Per ton. |
| [illegible] | $3.013 | $4.4916 | $3.5785 | $4.9809 | $5.2033 |
| Expense, reduction ....... | 2.1[illegible] | 2.5372 | [illegible] | [illegible] | [illegible] |
| [illegible] reduction | $0.853 | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | | | | | |
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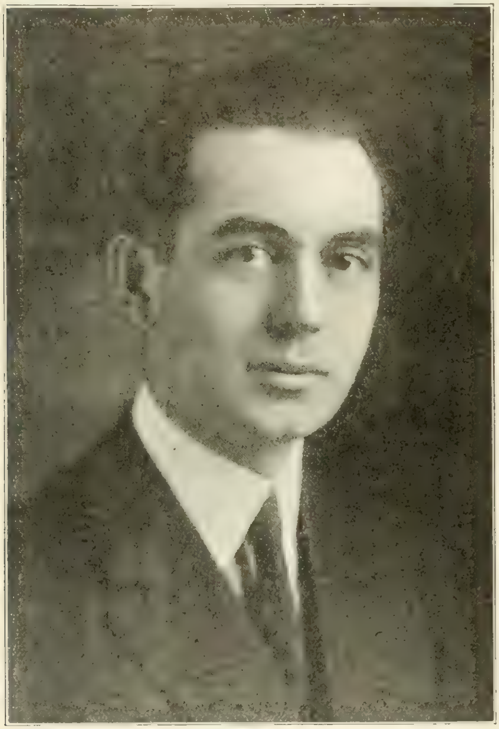
**Oklahoma Regulates Water Supply and Sewage Plans.**—Under provisions of the last session, 1917, by the Oklahoma State Legislature, all construction of public water supply systems and sewage disposal is now under the supervision of the State Board of Health. Plans for such construction must be approved by the Board before the contracts are let.

## Wm. M. Kinney Appointed General Manager of the Portland Cement Association

Wm. M. Kinney has been appointed general manager of the Portland Cement Association to succeed H. E. Hilts, resigned.

Mr. Kinney has been connected with the cement industry in cement and concrete promotion work for over 11 years, having occupied for the past four years the positions of Engineer, Promotion Bureau and Inspecting Engineer of the Universal Portland Cement Co.



Wm. M. Kinney.

He is an associate member of the American Society of Civil Engineers and American Railway Engineering Association, a member of the American Society for Testing Materials, American Concrete Institute, Western Society of Engineers, Engineers' Club of New York, Engineers' Club of Philadelphia, and Chicago Engineers' Club. He has been particularly active in the work of the American Society for Testing Materials, being vice-chairman of Committee C-1 on Cement and a member of the executive committee. He is a member of the executive committee and secretary of the committee on concrete roads and pavements of the American concrete institute.

Mr. Kinney was largely instrumental in establishing the Structural Materials Research Laboratory at Lewis Institute, Chicago, under the direction of Professor D. A Abrams, and has been since its inception, a member of the advisory committee.

**Philadelphia Wastes 80,000,000 Gal. of Water Daily.**—At a meeting of the Joint Special Committee of Councils of Philadelphia last week Carlton E. Davis, chief Bureau of Water, stated that "Of the 300,000,000 gal. of water pumped every 24 hours at the different pumping stations of the water system at least 80,000,000 gal. are wasted." Three ordinances for the meterization of all dwellings in Philadelphia are now under consideration. The first measure provides that the city pay the cost of installing meters, which is estimated at $6,000,000, the money for the same to be obtained by a loan. The second authorizes the city to do the work of installation by contract and collect the cost from property owners. The third measure, which is favored by the committee, directs property owners to procure meters direct from manufacturers, payment for which can be made by installment.

## Personals

**Thomas L. Willis** has been appointed city engineer of New Orleans, La., to succeed the late W. J. Hardee. Mr. Willis is 37 years old, a graduate of Tulane University and from 1908 until 1914 he was first assistant engineer to Captain Hardee. In 1914 he became superintendent of the municipal asphalt plant, which position he held until his appointment as city engineer.

**M. William Ehrlich,** after a completed war service of ten months at the U. S. Government Explosives Plant, Nitro, W. Va., as engineer on progress for the Thompson-Starrett Co., has returned to New York City. He has associated with the George H. Gibson Co., Tribune Bldg., New York City, which is an organization of engineering and editorial specialists engaged in the commercial development of mechanical business and their products.

**J. H. Libberton,** formerly division engineer, Promotion Bureau, Universal Portland Cement Co., has been appointed inspecting engineer and engineer, Promotion Bureau, succeeding Wm. M. Kinney. Mr. Libberton has been with the Universal Portland Cement Co. since August, 1908. Since February, 1917, he has been secretary-treasurer of the American Concrete Pipe Association. He is also a member of the American Concrete Institute, Western Society of Engineers, and the Chicago Engineers' Club.

**H. R. Abbott,** sanitary engineer, of Chicago, who has been stationed at Washington, D. C., for the past year with sanitation section of the construction division of the army, engaged in the design of sewer systems and sewage disposal works at the various army camps, has been assigned to Fort Sheridan, Ill., where he will have charge of the construction of the sewer system and disposal plant to be built at that place. Prior to his government service Mr. Abbott was in charge of intercepting sewer work for the Sanitary District of Chicago, on the North Shore and Evanston systems.

**Dwight P. Robinson & Co., Inc.,** constructing engineers, has opened offices at 6th and Broadway, New York City. At the head of this new organization is Dwight P. Robinson, who has, for 25 years, been associated with Stone & Webster in the management of their electric railway and lighting properties, as president of the construction and engineering branch of their organization, and since 1912 as a member of the firm. Associated with Mr. Robinson are R. M. Henderson, C. W. E. Clark, D. L. Galusha, M. E. Thomas and R. A. Phillips. Mr. Henderson, who for the present will have charge of construction, was with the Stone & Webster organization for 12 years, seven of which were as assistant construction manager at Boston, and three as district manager at Chicago. Mr. Clark was with Stone & Webster for 7 years, five of which as mechanical engineer and head of division. Mr. Galusha has been working under Mr. Robinson's direction for 12 years—the past five as head of the electrical division. Mr. Thomas, who will have charge of structural designs in the new firm, has been in a similar capacity for Stone & Webster for 9 years. Mr. Phillip has been associated with Mr. Robinson for 18 years.

## Obituaries

**Chistopher Deible, Sr.,** a sewer contractor of Youngstown, O., died Dec. 3, aged 87.

**Lieut. Charles H. Lembke,** formerly an engineer and contractor of Albuquerque, N. Mex., was killed in action in November.

**Frank K. Pingry,** for 17 years assistant engineer of the Essex County (N. J.) Park Commission, died Dec. 1, at Newark, N. J., aged 70.

**Alonzo C. Bell,** for 4 years city engineer of New Orleans, La., and later assistant engineer of New Orleans Dock Board, died Dec. 1, aged 59.

## Industrial Notes

**The Electro Bleaching Gas Co.,** of New York City, announces that its Chicago office which has been temporarily closed on account of the war is to re-open and will be in charge of Mr. G. R. Ellis as formerly. It will be located at 11 La Salle St. as heretofore.

**L. E. Schumacher,** who for the past 8 years has been chief inspector of the Westinghouse Electric & Manufacturing Co. at East Pittsburgh, Pa., has been promoted to works manager of the Krantz Manufacturing Co., of Brooklyn, N. Y., the latest subsidiary of the former company.

**The H. W. Clark Co.,** manufacturer of Clark Meter Box and Waterworks Appliances, Mattoon, Ill., has moved into its new factory, which was built to replace the one destroyed in 1917 by a tornado. The new plant is substantially constructed of brick, stone, concrete and steel with steel sash daylight construction throughout. Great care and attention has been given to the most convenient layout to reduce to a minimum the unproductive travel, the raw material coming in from one end of the plant and the finished product going out the other end. The most modern and complete equipment has been placed in this plant. The entire molding floor is supplied with electrically driven overhead trolley conveyors for handling the molten metal and the rough castings from the sand. The yard and the balance of the entire plant is equipped with overhead trolleys and with industrial tracks. The charging floor of the cupola is made up of steel and reinforced concrete, the fireproof features being carried throughout. In equipment there has been provided new patterns and flasks of the most modern construction and specially constructed molding machines are used throughout. In addition to foundry equipment there has been purchased a lot of special machine shop equipment.

*Railways and Gov't Works Monthly Issue*

# ENGINEERING AND CONTRACTING

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The *articles* in the first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering and contracting field. The *articles* in the first and last issues of each month (1st and 4th Wednesdays) completely cover county engineering and highway engineering and contracting. The *articles* in the third and last issues of each month (3rd and 4th Wednesdays) completely cover steam and electric railway location, design and construction. See the "mast head" on the first page of the Weekly News Section for information about our weekly contract news.

**Roads and Streets—1st Wednesday**
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies

**Waterworks and Hydraulics—2nd Wednesday**
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power

**Railways and Govt. Works—3rd Wednesday**
(a) Excavation and Dredging (c) Harbors and Docks
(b) Rivers and Canals (d) Railway Construction

**Buildings and Structures—4th Wednesday**
(a) Buildings (c) Ship Construction
(b) Bridges (d) Miscellaneous Structures

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Volume L. CHICAGO, ILL., DECEMBER 18, 1918. Number 25.

## E. & C. Index Furnished Only on Request

Hitherto it has been customary to send the index of our articles to every subscriber. In order to conserve paper the index for the six months ending Dec. 31 will be sent only to subscribers who send a postal card or letter requesting a copy of the index. It will assist us if those desiring the index will notify us at once.

## Public Works on a Large Scale Necessary During the Readjustment Period

In a recent speech Charles Evans Hughes said that with the end of the war "serious labor conditions are looming on the horizon." He said that in order to take up the labor slack an effort should be made to start immediately all important public work throughout the country which has been held up during the war. That is all well enough as far as it goes, but the amount of public work held up by the war totals less than half a billion dollars, or almost as much as this country has been spending every ten days for war purposes.

Apparently few men in public life seem to have an adequate conception of the vast amount of public work that should be begun next spring if there is not to be serious industrial trouble. It will not suffice merely to talk in vague terms about the necessity of starting public work on a large scale. Some one should decide what is meant by "a large scale." A billion dollars worth of public works is not "a large scale" even in normal times. In these abnormal times it is, in fact, a small scale of expenditure; for a billion dollars would scarcely pay for three weeks' expenses of the war.

The war has diverted one-third of the gross annual income of all the individuals and companies of America into unusual channels. Not less than two years will be required to restore business to normal conditions, and during this period of readjustment there will be a great deal of distress among workers unless Federal, state and city governments undertake a very great amount of public work.

In deciding what will constitute public work on a large scale it will be necessary to cast every precedent aside, even as it was cast aside in deciding what constituted conducting the war on a large scale. The war was absorbing one-third of the gross income of the entire nation, or $18,000,000,000 a year. It has suddenly ended, and men are being discharged at the rate of more than 50,000 a day. To expect, as President Wilson does, that most of these men will speedily find new work is to expect the impossible. To think, as Mr. Hughes apparently does, that a return to normal expenditures for public works will suffice to alleviate labor conditions greatly, is equally erroneous. Nothing short of Government appropriations of billions of dollars for land reclamation, highway and railway construction, etc., aided by other billions from cities and states, will prevent a very serious general slump in business.

The effect of discharging several millions of workers and soldiers will not be confined to those men and their families. It will spread. Having lost their incomes, they will not be able to continue their normal expenditures, which will at once injure the merchants. The merchants will consequently curtail orders from the jobbers and factories. In steadily widening circles the progressive curtailment will proceed, possibly for two years before the reaction begins, unless the Government comes to the aid of industry.

It is true, of course, that America has more wealth than ever, that it has its farms, its factories, its mines and all its productive plants, even more efficiently equipped than before the war. It is true that the gold per capita never was so great. All this is true and more. Yet these very truths existed in 1873 and in 1892, just prior to the two greatest financial panics of modern times. Men repeatedly forget the part that psychology plays in every abnormal situation such as we now face. They forget that the confidence of business men and bankers is easily shaken, and that when they see an increasing slackening of business they themselves put on the brakes that reduce the industrial momentum still more. All this is forgotten by those who look only at physical conditions and forget psychic phenomena.

We are now faced by the greatest and most sudden industrial change that has ever confronted this nation. No panic is likely to seize upon us; but, on the other hand, the majority of business men are so uncertain as to what will be involved in the readjustment that relatively few will venture to do more than drift with the current. Most of them look for some decrease in wages and prices of materials, and will hesitate to order stocks of goods and supplies. They will hesitate still more about buying new machinery and equipment. Everyone will be inclined to wait for lower prices.

It has been argued that the reconstruction of France and Belgium will alone stimulate our business greatly. Those who argue thus lose sight of the relative insignificance of all the reconstruction there compared with the vast productive power of the nations that stand ready to assist in the reconstruction.

It has been held that the war has shown to all the nations of the world what American machinery and methods can accomplish, and that we may look for unprecedented sales of our machinery in Europe and Russia. True, but when will those sales materialize? It takes months and years to create a large foreign trade even among prosperous nations. In the case of nations loaded with war debts, who dares prophesy how long it will be before they feel able to buy on a large scale from America?

All hopes of foreign business are merely hopes at present, but we face one fact about which there is nothing problematical, and that is that millions of men are about to be discharged.

Our readers need not worry over this outlook in so far as their own personal welfare is concerned, for it is certain that public works construction will be abnormally active for years to come; but it is the public duty of civil engineers in particular to aid in securing as large appropriations for public works as possible, and to indicate the wisest ways of expending such moneys. As economists it is peculiarly the function of engineers to lead the public to employ the men who will soon be idle, and to direct their labor in a manner that will add to the wealth producing capacity of the entire nation.

This is a nation of mud roads—90 per cent mud. More than half our city streets are unpaved. Not a quarter of our urban population has filtered water. Millions of acres of reclaimable land are too dry, other millons are too wet. Our railway system is outgrown, and should, moreover, be almost entirely electrified. There are, in fact, countless places where millions of men can be profitably employed by the public for years to come. Every engineering society in America should throw its entire weight into the campaign for the continued sale of Government bonds with which to build greatly needed highways and other public and semi-public works.

# President Wilson "Passes the Buck" as to Government Ownership

In another column we have quoted part of President Wilson's address to Congress, the part relative to the disposition to be made of the railways. The President does not suggest any solution of the problem, further than to say that new laws should be enacted to do away the pre-war conditions of railway "restraint without development." He evidently condemns the old system of the regulation of railways by the 48 states and he condemns also the "wasteful competition" that was forced upon the railways by the Sherman act. But as to the whole problem he says to Congress: "I frankly turn to you for counsel upon it. I have no confident judgment of my own."

In the last respect he differs from his last presidential adversary, Charles E. Hughes, who recently expressed himelf as opposed to Government ownership of the railways. In that connection he said:

> It is regrettable, but it is true, that governmental enterprise tends constantly to inefficiency.
>
> It can not fail to be observed that even in connection with the war, despite the endeavor and patriotic impulse of countless workers, inefficiency in important fields of activity was notorious.

President Wilson is quite right in saying that the railway problem is both complex and of great moment. Perhaps he wisely "passed the buck" to Congress. Congress would be wise to "pass the buck" to a committee of engineers of broad experience.

Certainly before any action is taken looking toward Government ownership, Congress should send engineers to Europe to report upon the economics of Government railways in France, Germany and Italy. It was the sight of those railways for a few weeks that led William Jennings Bryan to return to America, a dozen years or more ago, with a life-long conviction that Government ownership was far preferable to private ownership. Snap-shot decisions of that sort, even by expert engineers, are usually untrustworthy; and when made by men wholly without training in engineering economics, such judgments are worth no serious consideration.

It may be that the Government-owned railways of Europe are more economic than American railways privately owned. Who knows? Never has any skilled body of experts investigated the matter. The unit costs of equivalent railway service in American and Europe have never been analyzed so that a thorough comparison could be made. Such evidence as we have had has been fragmentary, and, for the most part, has not been unfavorable to American railways. What is needed is a non-partisan report by engineers, some of whom are skilled railway engineers and some experts in cost analysis.

A thoroughly unscientific method of deciding between private and public ownership of railways would be to debate the question in Congress and in the newspapers, without any comparable costs upon which to base the arguments. Under such conditions a vast economic problem would be decided without any cost data, The reasoning would then all be of the purely deductive type in which at least one of the premises of every syllogism would have to be assumed. Thus those who favored Government ownership would say:

"The highways of a country should never be exploited for the profit of individuals. Railways are highways. Hence railways should not be exploited by individuals." Grant the major premise and the conclusion follows, but the opponents of Government ownership refuse to grant it. They, with equal futility, argue thus: "Men working for a government are not as efficient as when working for themselves or for other men that are working for profit. Hence after a few years of Government operation, American railways will become uneconomic and as unprogressive as the Government-owned railways of Europe have been for generations."

One assertion can always be found to offset another, as readily as one general theory can be framed to contradict another. The methods of science, engineering methods, always involve proof by facts. Is this method more economic than that? The scientific answer does not consist in mere appeals to theories. It consists in securing unit cost data that can be compared. Indeed, no economic problem was ever correctly solved save by an appeal to specific costs and values. This holds not only of all economic problems of an engineering nature, but of all economic problems of a social or political nature. The fact that in solving problems in political economy it is often difficult to secure the data of cost and value, usually serves as an excuse for trying to solve the problem without such data, severely by deductive argument and analogical reasoning. But the fact remains that no problem in political economy ever was solved or ever will be solved in such a manner. Solutions may be guessed at, and the guesses may be right; but engineers, at any rate, have no patience with guessing.

The problem of Government ownership of railways is a clean cut problem in economics. The main question is: Which plan, in the long run, will yield adequate rail transportation at the lowest cost to the public, Government ownership, or private ownership, or a partnership between the Government and the stockholders? The problem is susceptible of accurate solution, but it will involve the employment of expert engineers not only to secure the necessary cost data in Europe and America, but to analyze the data and reach a conclusion.

## Individual Initiative as a Factor in Industrial Development

Under private ownership a single able man or a small group of able men can readily secure capital for any enterprise that bids fair to be profitable. Under public ownership it is usually difficult to secure adequate capital promptly if at all. Neither the voters nor their representatives are keenly interested in public works, for they derive therefrom no personal profit that is easily measured. This is very well illustrated in the case of roads. For more than 25 years there has been an increasingly vigorous campaign of publicity in America for better roads. But the entire effect of all this publicity has thus far been almost nil when contrasted with the economic need of a vast system of good highways.

On the other hand, up to the time that repressive regulation of railways by Federal and state commissions began to have effect, American railways grew rapidly.

Speaking recently on private ownership of industries, Charles M. Schwab said:

> The real development of any great enterprise depends on the individual initiative of the American business man. I do not believe we will ever get the full economical development of any great branch of American industry that is not developed under private capital.

He unquestionably voices the belief of the great majority of successful business men; but men who have had little or no business experience are prone to reject such opinions on the ground that business men are biased. Without doubt some bias in favor of private ownership of railways and other industrial plants does exist among men like Schwab, but no class of men is entirely free from bias. The first question that the public should ask is, Who is more biased, a successful business man like Schwab or a politician like Postmaster General Burleson? The next question should be, What have been the economic results under public ownership as contrasted with private ownership? A correct answer to this second question is, after all, the important thing to seek; for actual data are not biased, and, if properly analyzed and compared, they will tell the tale.

As pointed out in another editorial, there is a tendency to try to solve problems in political economy merely by deductive reasoning from general premises. But such a method, while it may point the way toward a solution of an economic problem, can never furnish the solution itself. Nothing less than an appeal to actual statistics will lead to a correct solution of any economic problem. The training of engineers peculiarly fits them both to analyze and interpret statistical data. For this reason, among many, we have long urged civil engineers to study political economics, and to take an active part in politics. Engineering societies, both local and national, should appoint committees to investigate and report upon specific problems in political economy, such as metering of water consumers, public ownership, methods of payment for pavements and roads, limitations of municipal indebtedness, and a hundred and one other economic problems of local or national importance.

It takes time and often it takes money to gather and analyze statistics for such reports, but we doubt not that many engineers will gladly contribute time and that many wealthy men will contribute money for investigations that will benefit the public.

## How Many Engineers Are There in America?

In Prof. Charles R. Mann's report on engineering education it is stated that up to 1870 the total number of graduates of all the engineering schools in America was 866, and that there were only 7,374 practicing engineers in 1870. Up to 1915 the total number of engineering graduates was 55,000, but 39,000 of these graduated subsequent to 1880. Prof. Mann estimates that there are 80,000 men who could qualify for membership in the four great national engineering societies, and that about 40,000 are graduates. We regard the 80,000 as an underestimate, for the census of 1910 indicates that there were more than that number eight years ago. The 1910 census shows:

| | |
|---|---|
| [illegible] | [illegible] |
| [illegible] | [illegible] |
| Civil engineers and surveyors | [illegible] |
| Electricians and electrical engineers | 135,519 |
| [illegible] | [illegible] |

Although many of the draftsmen and surveyors could not qualify as engineers, and although almost none of the "electricians" could so qualify, it seems evident that fully 100,000 men could have qualified as engineers in 1910.

The total number of engineers recorded in the census doubled between 1890 and 1900, and it more than doubled between 1900 and 1910. There is reason to believe that the increase during the past eight years has been fully 50 per cent; for in the 10 years of 1901-1910 the engineering graduates numbered 21,000 as compared with 17,000 in the six years of 1911-1915.

It is our belief that there are now fully 150,000 Americans who can qualify as engineers. The total membership in all the societies having headquarters in the Engineering Societies Bldg. in New York is 53,000, of whom about 30,000 are members of the four great national engineering societies.

## Concrete Roadbed for Railways

To the Editor: I was particularly interested in reading the article in your July 17 issue regarding the concrete roadbed on the Northern Pacific Ry.

My personal interest in concrete roadbed construction goes back to the early part of the year 1907. You probably remember that at that time there was quite an "epidemic" of railroad accidents due to spreading rails, which in turn is traceable to the effects of frost upon the roadbed.

With the object of explaining the cause of these accidents and suggesting a method of preventing them in the future, I prepared an article which was published in the Dexter, Kansas, Dispatch on Thursday, July 11th, 1907, and which describes in considerable detail a roadbed construction of concrete which embodies many of the features described in your article about the Northern Pacific construction.

At that time my experience in reinforced concrete had not been anywhere near as extensive as it has now, so I made my design for the use of mass concrete rather than for the more modern reinforced type. However, my design had one feature which I believe could with profit be included in the Northern Pacific design, that is provision for readily removing and replacing the wooden spiking blocks whenever necessary.

CHAS. F. DINGMAN.

Palmer, Mass.

## We'll Suggest It to President Wilson

To the Editor: After reading your editorial in the Nov. 6th issue and then reading the accompanying clipping from the Milwaukee Sentinel of about Nov. 1st, one is inevitably led to the conclusion that here is another chance to criticize the government. By this time the poor old Eskimos should have had asphalt streets, washed daily, or at least Tarvia on top of the snow to lay that influenza dust.

ESKIMOS IN ALASKA
ARE INFLUENZA VICTIMS

**NOME, Alaska.** — Nome has been stricken with influenza. About 300 white residents on Thursday were reported suffering and Eskimos in nearby villages were said to be dying by scores. The weather has been below zero for several days.

F. A. BOTTS.

Central Aguirre, Porto Rico.

## "Rail Creep"

To the Editor: I was glad to note in your Oct. 16 issue my communication on "rail creep." I hope it will be the starting wedge to eliminate a mechanical leak in railroad operation that has coal wastage and water leakage "backed off the boards." One of the most prolific causes of unfair usage of rails is the method of mounting the motor (electric) on the axle, solid without cushion, which causes the wheels to deliver steam hammer blows to the rail joints, setting up what is known as corrugation or waves, and shortening the life of rails, frogs and crossings 50 per cent. Regarding this you will find an article in the Sept. 21st, 1917, Railway Gazette (London) on corrugation, by the undersigned, and an editorial on same in the Oct. 12th issue. One defect with steam railway operation is the use of obsolete running gear under freight cars, which caused two wrecks still fresh in our memory—Amsterdam, N. Y., April 8th, 1918, in which the freight cars spilled over on the passenger tracks and wrecked two heavy passenger trains, and the circus train wreck near Chicago June 22nd, 1918. Another defect is the use of weak track for the heavy equipment, which is putting a 10-ctory house on a 5-story foundation, the track being of an obsolete design, on a par with the mining tracks, and a relic of steam tracks 30 years ago. In this respect, in the same boat with the freight car. The standing signal makes it is difficult for the engine-man to read the signals in clear weather, even if his vision is not obstructed by the large boiler, augmented by smoke and cinders. You will find an article by the writer on "Running Down Signals," in Engineering, London, July 27th, 1917, page 101.

New York, N. Y. JOHN FRANCIS.

**Removal of Debris from Drill Holes.**—The following method is employed at an Oklahoma quarry for removing debris from drill holes before loading: A gas pipe tripod is placed over the hole. By means of a rope and pulley a section of gas pipe is then lowered into the hole. By repeatedly raising the pipe several feet and allowing it to drop, it gradually sinks into the debris. Compressed air is then forced through the pipe and blows the refuse out. If the material is too coarse to be blown out, it is first cut up with a steel bar. As the cost of cleaning some drill holes has exceeded the original cost of drilling, all holes recently drilled by this company are now cased at the top and carefully plugged.

## Hydraulic Stripping in Quarrying

Hydraulic stripping is practicable where there is an abundant water supply and good drainage. If the conditions are favorable it is one of the cheapest methods that can be used.

The usual method of hydraulic stripping is to pump the water through pipes and force it at high pressure through a nozzle directed against the bank. If the water has to be pumped some distance, it has been found advisable, in order to reduce the loss of power by friction, to use pipe of 4 or 5-in. diameter, close to the pumping station, and to reduce the size at successive intervals. The jet from the nozzle is usually so directed as to undermine the material and let it fall in a loose mass. It is then easily carried away in the stream. It is obvious that boulders too large to be washed away retard the process, and if the material contains many boulders the use of a steam shovel may be preferable

In a quarry in northeastern Missouri where this method is employed a ravine affords a means of drainage back from the quarry face As the material is rather hard holes 8 to 10 ft. deep are bored with a soil auger, and the ground is loosened with small charges of explosive. The cost of stripping is said to be about 7 ct. a cubic yard.

Rough Rock Surface Effectively Stripped by Hydraulic Method.

In an Indiana quarry stripping with steam shovels is supplemented with hydraulic stripping during seasons when the water supply is adequate. The material is washed down a channel, which is nearly parallel with the quarry face, and into a creek. A settling basin has been provided, but complaints are sometimes made of the turbidity of the stream below the basin. The effects of hydraulic stripping may be far reaching, and the operator must carefully consider a possible conflict with other interests.

In one quarry in eastern Missouri the conditions are unusual. The quarry is situated on a bluff facing the river. The water supply is therefore abundant, but the drainage is toward the quarry face, whereas in most localities where hydraulic stripping is practiced the water may be drained away from the quarry pit. Owing to this condition the soil-laden water must be conveyed through and aqueduct from the quarry face to the river bank. However, the operators claim that the cost of hydraulic stripping, including the construction and maintenance of the aqueduct, is considerably lower than with steam shovels.

At one Virginia plant, where the hydraulic method is employed successfully, the quarry faces a river. The overburden consists of red clay and sand, varying in thickness from 2 to 15 ft. Clay seams and clay pockets are abundant. Stripping is conducted during the winter months, when the resulting turbidity of the stream causes the least inconvenience to other industries. Work on rock quarrying is suspended during the stripping. The rock surface dips toward the river, and the overlying material is washed down onto the quarry floor. A row of barrels filled with earth placed near the river bank serves as a dam or weir to hold back the bulk of the stripped material, which would otherwise obstruct the stream. This material, after it becomes comparatively dry, is loaded into cars with a steam shovel and removed to a dump. To those unfamiliar with the conditions in this quarry, it would seem more reasonable to remove the overburden with a steam shovel in the first place. The rock surface is, however, so deeply eroded that steam-shovel work would be impossible. The illustration shows the extreme irregularity of the stripped surface. This view, states Mr. Oliver Bowles in a bulletin, "Rock Quarrying for Cement Manufacture," issued recently by the U. S. Bureau of Mines, is an excellent example of the effectiveness of the hydraulic method in removing soil from erosion cavities.

## Charcoal Evidence of Corners as Set by U. S. Surveyors

Interesting information on the use of charcoal for marking of Government corners was given by Mr. A. S. Doty of Kansas City, Mo., in a recent ejectment suit in which he acted as expert witness. His statement on the matter follows:

As to the choice of this substance as a means of the perpetuation of corners, I know little, having never seen a printed line on the subject. I have heard a theory that it was selected on account of its lightness, or that it was easy to transport by man power. The substance is more or less non-destructible, but is easily shifted as to position by the slightest flow of water.

It can also be said to be a common substance especially in the timbered or semi-timbered regions of the country where all the earlier operations of farming were closely connected with the felling and consumption of timber. The earliest fences, although now often forgotten, were brush fences. A settler cleared a space and used the brush for a fence, burning it later when rails were ready. As fast as stumps were seasoned they were burned in place, often leaving a pocket of charcoal in the ground where the fire followed down the roots of the tree. In an earlier day wood was burned in the open on many occasions. The outskirts of the timber were largely hazel, sumac and other small growths of timber. These had little use and were largely burned on the ground in order to make way for blue grass pasture land.

As to the charcoal being used in perpetuating government corners, it may be said to have been an excellent medium as to longevity or durability, but not as to stability of location. The color was also not favorable for the purpose of perpetuating corners, as the dark loam soils gave no contrast by which the charcoal could be recognized. It is also true that the clay loam soils of North Missouri have in the first foot of depth lumps of different size in their composition. Of this in timbered lands I have no explanation except that nuts and acorns may have decayed and have become imbedded in the soil and later turned to a darker loam than the soil surrounding them. The depth at which this charcoal was reported buried should have much to do with the reasonableness of its reported discovery. Where it was reported left on top of the ground or a few inches under it is not reasonable to expect it to remain unchanged as to location, especially in timber lands where the soil was a loam and where no grass was growing unless the ground was level. A covering of earth in timberland would become washed down either on a level surface or on an incline. The heavy rains of spring in north Missouri would probably wash down any mound left by government surveyors unless a sod was forming to hold it in place. It is also true that one class of animals, the common swine, feed on charcoal. Any charcoal left near the surface or on top of the surface would be subject to destruction by this kind of stock, if at large in the vicinity.

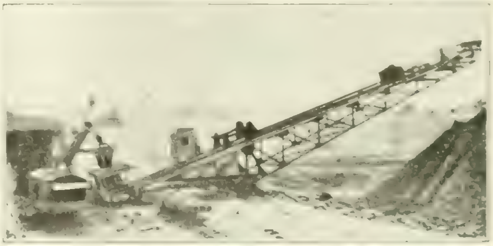
As to the original post as reported set, the common theory is that they were cut as near to the corner as it was possible to procure them, and that they were round and never split. The labor of walking long distances through an obstructed course was all the parties could undertake. They reported driving a stake and depositing usually 2 quarts of charcoal around it, sometimes on top of the ground and in places 3 inches under the ground. The charcoal was probably a witness to the stake. When the stake should decay, then the retracer was to carefully skim off the top of the soil, watching for the appearance of charcoal. When the charcoal was discovered it should lay in a sheet and be about the quantity reported. At this point authority says that a marking pin shall be jabbed down in different places in the charcoal bed till a soft spot is found, indicating the location of the stake. If found in a clay soil by removing part of the charcoal, the shape of the stake may be shown by the dark color of the cavity left by the stake. If this is not sufficient, the surveyor should dig vertically on one side of the stake till a side view of the cavity or rotten stake can be seen, always being careful to leave half of the charcoal bed in place and half of the cavity intact if the soil will hold. A study of the cavity may show a sawed stake or a sawed split stake, a split stake or a round stake. A government corner might show a round stake cavity with a sawed or split stake cavity reaching farther down, the second stake being a renewal. Any cavity reaching too far down would probably not be made by a stake driven by government surveyors.

In no case should vertical digging endanger the original position and lay of the government evidence, and in clay soils, about one-half of the charcoal bed and stake cavity should remain untouched in the operation. A stone could be set at the side of the remaining evidence.

Any use of the site of a charcoal corner by a public highway would probably be fatal to the identifying of stakes and charcoal as reported set, especially where the road is located in timber lands and where it was used for many years ungraded. It is unbelieveable that such markings could withstand the travel in times of freshets and spring thaws, when the roads often become impassable.

## Quarry Stripping with Conveyor and Steam Shovel

Stripping at an Ohio quarry is handled very economically by means of a conveyor operated in connection with a steam shovel. The method is described by Mr. Oliver Bowles in a bulletin, "Rock Quarrying for Cement Manufacture," issued recently by the U. S. Bureau of Mines. The soil to be removed is 30 to 45 ft. thick and the bed of rock beneath is only 8 ft. thick. As the rock is removed, the area worked out is available for disposal of overburden. The equipment, as shown in the illustration, consists of an inclined bridge-like structure of steel mounted on wheels. On this incline, two independent cable cars on separate tracks are operated with an electric hoist. The cars are loaded with the steam shovel, hauled up the incline, and dumped. The total length of the conveyor is 175 ft., and it places the material 150 ft. from the steam shovel. The shovel has a 2½-yd. dipper, and each car is of 5-yd. capacity. The whole machine may be moved forward as the shovel is advanced. The company claims that stripping can be done by this method at an actual working cost of 2 ct. a cubic yard, not including overhead charges, depreciation, or interest on the investment, and that with a gang of 9 men 2,000 yd. can be handled per day. The equipment is well adapted for stripping back into pits from which all serviceable stone has been removed.


Conveyor and Steam Shovel for Stripping in Ohio Quarry.

# Views of American Industries on Industrial Readjustment

A new and powerful federation of American industries was created at the Reconstruction Congress of Industrial War Service Committees, Dec. 4, 5 and 6, at Atlantic City. This association, made up of the nearly 400 War Service Committees that were formed under the direction of the Chamber of Commerce of the United States, was created by the committees to act in the future as the spokesman for industry before the Government just as the committees acted separately as the point of contact between industry and the Government during the war period.

The Federation voted to function under direction of a committee of the Chamber of Commerce and it will have back of it and serving it the chamber's organization. When necessary it will have, too, the benefit of the weight of the expression of the membership of the chamber. The chairman of the War Service Committees will sit as an Industrial Advisory Council to the organization.

The views of this assemblage of industries respecting industrial readjustment were expressed at Atlantic City in a series of resolutions covering the most important subjects that today engage the attention of business men. Some of these resolutions of particular interest to engineers and contractors follow:

**Cancellation of War Contracts.**—It is in the public interest that all war orders placed by any contracting agency of the Government and accepted in good faith, whether formally and regularly executed or not, should, upon cancellation by such contracting agency, be promptly and equitably adjusted and satisfied as if every formality had been observed, and when so adjusted the amount ascertained to be due by the Government should be promptly paid, to the end that these funds may be utilized by the industries of the country to speed their transition from a war to a peace basis.

If it should be ascertained that legislation is necessary or desirable to accomplish this end, Congress should forthwith enact such legislation.

Officials dealing with questions of adjustment on account of war orders must necessarily be familiar with all the conditions affecting the orders. It will greatly promote expedition and the interests of both the Government and private enterprise for the officials who made the contracts to remain in the Government service to participate in the readjustment.

**Removal of Restrictions on Industry.**—It is in the public interest that all war regulations of industry should be revoked, and all war restrictions on industry should be removed, as speedily as practicable, save in the case of such industries as are engaged in the production, preparation or distribution of foods, feeds, and fuel, and such last-named group of industries should be freed from war regulations and restrictions as early as consistent with the welfare of this nation and of the Allies.

**Industrial Co-operation.**—The war has demonstrated that through industrial co-operation great economies may be achieved, waste eliminated, and efficiency increased. The nation should not forget, but rather should capitalize, these lessons by adapting effective war practices to peace conditions through permitting reasonable co-operation between units of industry under appropriate federal supervision. It is in the public interest that reasonable trade agreements should be entered into, but the failure of the Government either clearly to define the dividing line between those agreements which are, and those which are not, in unreasonable restraint of commerce, or to provide an agency to speak for it on application of those proposing to enter into such agreement, in effect restricts wholesome co-operation and deprives both industry and the general public of its benefits. The conditions incident to the period of readjustment renders it imperative that all obstacles to reasonable co-operation be immediately removed through appropriate legislation.

**Relocation of Labor.**—The conversion of the industry of the country from a peace basis to a war basis involved a general and important dislocation of labor. This movement was gradual. The end of the war involves a much more rapid change in industry; while there will be a great demand for labor to meet the foreign and domestic requirements, there may be for a time in special places a temporary condition of unemployment.

In the new relations of industry to labor we conceive it to be incumbent upon the community affected promptly to meet such conditions.

The local chambers of commerce should be able to contribute in an important way in this work.

**Public Works.**—The development of public works of every sort, as recommended by the President, should promptly be resumed, in order that opportunities of employment may be created for unskilled labor.

**Taxation.**—The cessation of hostilities brings to business interests a feeling of deep concern in the matter of taxation. The problems of readjustment are made more difficult through inequalities in the present law.

We believe, therefore, that in the consideration of amendments to the present act, or the passage of new revenue legislation, the Congress should give most careful consideration to the views expressed by organizations of commerce and industry. Ability to pay, inventory values, and proper reserves, together with careful survey of the amount of revenue required under the new conditions, are matters of vital importance to business interests of the nation during this readjustment period.

**Railroads.**—The Congress of the United States should speedily enact legislation providing for the early return under Federal charters to their owners of all railroads now being operated by this Government under Federal regulations permitting the elimination of wasteful competition, the pooling of equipment, combinations or consolidations through ownership or otherwise in the operation of terminals, and such other practices as will tend to economies without destroying competition in service.

**Means of Communication.**—We are opposed to Government ownership and operation of telegraphs, telephones and cables.

**Merchant Marine.**—We recommend that the construction of a great merchant marine be continued and amplified, and that its operation under American control be kept safe by such legislation as may be necessary to insure its stability and its lasting value to American industries.

**Port Facilities.**—The recommendations of the Port and Harbor Facilities Commission of the United States Shipping Board for development of the American ports are supported. Vessels of foreign register needed for our commerce by sea are attracted to those ports which are best fitted to coal, to load, and to unload cargoes, and thus provide means for a quick turn-around. After ascertaining the port facilities of European countries, and their plans for further development, the Commission has recommended that there should be a local port commission at each of the important ports upon our coasts, that upon these commissions there should be representatives of industrial, commercial, and railroad interests centering at the port, that facilities should be installed to meet the needs of the port and that a zone system should be arranged by which exports and imports would flow through those ports which are within economic transportation distance of the points of origin and destination. There should be co-operation with the Facilities Commission in its task of expending means which will enhance the position of the United States among maritime nations.

**Public Utilities.**—Public utilities have faced difficult problems, which have been accentuated by conditions arising out of war. The development and efficiency of such a utility as local transportation has immediate importance for every community. It is recommended that the Chamber of Commerce of the United States should appoint a committee to investigate and study the question of local transportation as it relates to the control of rates and service, franchises, taxes, the attraction of capital into the business, and such other questions as the committee may find pertinent. Such a committee should report its recommendations to the Board of Directors of the National Chamber, and the board should deal with them in accordance with the established procedure of the chamber.

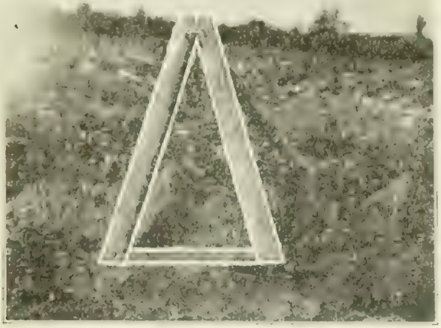
**Water Powers.** Industrial activity is dependent upon the available supply of power. A bill which would affect the development of hydro-electric power upon waterways and lands which are subject to Federal jurisdiction is now before a committee of conference between the two Houses of Congress. It is important in the public interest that Federal legislation on this subject should be enacted without further delay. We accordingly urge that the conference committee arrive at an acceptable form of legislation in season for enactment at this session of Congress.

**Forest Products Laboratories.**—The Forest Products Laboratories.—The Forest Products Laboratories of the United States Forest Service have rendered valuable service through scientific investigation of the physical properties of American woods and their adaptability for structural, industrial, and ornamental usage. It is of great importance to American industry that the Government should extend and adequately maintain the work of the Forest Products Laboratories.

**Cost Accounting.**—It is the sense of this convention that a system of uniform cost accounting should be adopted by each industry.

## Handy Tool for Use in Pulling Lateral Roots and Small Stumps

The accompanying illustration shows a tool that has given good service in connection with the tripod stump puller and dynamite in the clearing of sandy white pine stump land. It is used as a lever over which the team pulls to give additional power for the pulling of lateral roots and small stumps left in the ground by either the dynamite or the large puller.



This Device Increases Power of Teams in Pulling Roots and Small Stumps.

The log chain is passed through the ring shown at the top of the triangle and then around the snag or root to be pulled. The triangle is set up as shown in the picture, the top leaning towards the object to be pulled. As the horses tighten up on the chain, this gives a lifting power as well as a straight pull and as it comes over towards the team the power of the team is about tripled.

The two sides of the triangle are made of 4 x 4's and are about 4½ ft. long. The bottom side is made of a heavy round piece of wood and is 2½ ft. long. The ring is fastened into the top with a heavy bolt.

**First Concrete Ship of U. S. Shipping Board Launched.**—The reinforced concrete steamship "Atlantus," 3,500 tons carrying capacity, was successfully launched Dec. 3 at the yards of the Liberty Shipbuilding Co., Brunswick, Ga. The "Atlantus" is the first of the concrete ships contracted for by the U. S. Shipping Board Emergency Fleet Corporation to be finished. Sister concrete ships, as well as a number of concrete ships of 7,500 tons capacity, are being built in the yards of the Liberty Shipbuilding Co., and in four other yards established by the government exclusively for concrete ship construction.

## The Work of the Construction Division of U. S. War Department

In an address delivered Nov. 20 at the organization meeting of the Associated General Contractors' Association of America, Brig. Gen. R. C. Marshall, Chief of Construction Division, U. S. War Department, gave the following outline of the construction placed under the control and supervision of his division.

From the beginning of the war up to Nov. 1, 1918, the amount of money appropriated for construction work of all sorts aggregated $1,347,000,000.

There is only one state in the Union, viz.: Nevada, in which the construction division is not doing some work for the army.

At the present time (November 1) more than 400 projects are in the course of construction.

The construction division has dwarfed in size and speed the tremendous historical achievement—the Panama Canal. On that job, which required 10 years to build, the annual expenditures never exceeded $50,000,000 a year. During the past 16 months the work of the construction division has exceeded $800,000,000, or $50,000,000 per month.

In the camps and cantonments built by the construction division, the United States can train over 1,600,000 men at one time.

In type and nature, the work done by the construction division has been diversified in the extreme, varying from the small shelter costing less than $1,000 to house a few soldiers, to the huge port terminals or great ordnance jobs costing anywhere from $30,000,000 to $50,000,000.

Value of materials mobilized in single weeks during last summer ranged from $4,000,000 to $10,000,000. For the first week in November it was something over $7,000,000. As many as 10,000 workmen have been employed on a single project at one time. The division has had under its control as high as 350,000 workmen at one time.

Warehouse facilities alone, erected by the division within the past year have been of a tremendous magnitude. More than 34,000,000 sq. ft. of storage space has been provided for the necessities of the army. The cost of the warehouses will exceed $220,000,000 and many of them are of a permanent nature. The building of these immense storage facilities has involved also the construction of hundreds of miles of railroad trackage, docks and wharves, besides many miles of roadway.

The army supply base at Brooklyn is the greatest storage warehouse and terminal in the world. It will cost about $30,000,000. Two 9-story buildings of reinforced concrete construction make up the main installation. Each of these buildings is 200 ft. wide by 980 ft. long.

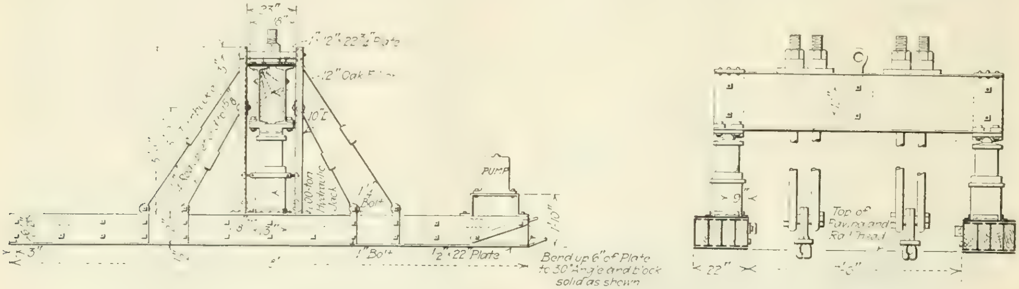
The work of the construction division, summed up briefly, has covered such diversified projects as camps, cantonments, arsenals, wharve, docks, forts, great port terminals, reserve storage warehouses, hospitals of all sizes and descriptions, aviation fields, proving grounds, embarkation camps, engineers' camps, gunnery schools, housing, lighterage, power plants, factories, additions to manufacturing plants, munition plants and special new plants for the production of nitrates, phosphorus, T. N. T., and other acids, gas and explosives.

It should be interesting for the American citizens to note that much of the work of the construction division has been designed, not for the destructive purposes of war, but as permanent constructive work that will be of immeasurable value to the country in the great days of commercial development which will now follow the cessation of hostilities. No less than eight huge port terminals are now being developed by the construction division at Atlantic, Gulf and Pacific ports. These mammoth terminals, all of which will be in partial, if not in complete, use within a few months, will provide this country with sufficient wharves, docks, and port facilities to handle the vast tonnage that will be sailing the seas under our flag within a short time and which will once more place the United States in the foremost ranks of maritime nations.

# Machine for Removing Street Railway Tracks from Paved Streets

By means of a specially designed machine the Los Angeles Ry Co. has been able to pull out 120 lin. ft. of track per hour in removing its roadway from paved streets. This track puller is described by Mr. Thomas M. Bulpin, Chief Engineer, Los Angeles Ry., in the Electric Railway Journal, to which we are indebted for the matter that follows:

About 18 months ago the company constructed approximately 700 ft. of double track in paved streets. The rail was P. S. Co. No. 292 section, 7 in. high and weighing 116 lb. to the yard. This rail was laid on 6-in x 8-in. x 6-ft. redwood ties spaced 20-in. centers. These ties were placed on a 6-in. crushed rock, cement grouted ballast and the entire rail paved in with concrete, making a solid concrete pavement 19 in. in thickness. This particular portion of track was part of a line recently abandoned by the company, and under the abandonment proceedings was required to be removed within a time limit.



Details of Machine for Pulling Track from Paved Streets.

To remove these tracks the company designed and constructed a machine which consists of two 200-ton hydraulic jacks, mounted on horizontal beams which straddle the track. These beams prevent the breaking of the pavement outside of the railway strip. The rail tongs are made to fit the special section of rail upon which work is being done. Although our practice has shown that there can be considerable leeway in this regard, the jacks are placed directly under the beam from which the rail tongs are suspended.

The preliminary work necessary consists of cutting out sufficient paving along the rail to permit of the placing of the tongs under the ball of the rail. This must be done at intervals of 10 ft. to 20 ft., depending upon the construction of the track to be pulled. The jacks are started and a lift of from 6 in. to 9 in. is sufficient to pull the rails entirely free from the ties and thoroughly break the concrete within the railway strip. This operation, including the moving of the machine, requires from 4 to 6 minutes.

The machine is moved along the track with an electrically operated Brown-Hoist crane, the operation consisting of raising the puller a few inches above the pavement and moving it entirely suspended to the next position. It has been found desirable to follow immediately behind the machine with two 15-ton hand jacks, as this facilitates the removal of concrete and paving blocks.

The company estimates that with this machine and six men, it can remove more track than it could with 200 men under the ordinary method of sledging and gadding.

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**American Engineer Regiments Built 843 Miles of Railroad in France.**—The American army brought over to France and had in operation on Nov. 11, 967 standard gage locomotives and 13,174 standard gage freight cars of American manufacture. In addition it had in service 350 locomotives and 973 cars of foregn origin. To meet demands which the existing French railways were unable to meet, 843 miles of standard gage railway were constructed.

# Reconstruction and the Building Industry*

BY WILLIAM A. CALDER.

United States Senator from the State of New York.

In order to understand the problems of reconstruction which the building industry is facing, it is necessary not only to review the factors which brought about a curtailment of building during the war, but to go back of that and study the condition of the industry just before the war. Even during this pre-war period there had been a gradual decline in building activities due to increasing costs of labor and material.

**Construction During the War.**—The history of the war orders of the past 13 months is well known to you. The first order issued by Judge Lovett, Oct. 27, 1917, restricted the use of open cars. Then came Secretary McAdoo's demand for the cessation of all building not essential to the prosecution of the war or immediately necessary for domestic welfare, followed by the increasingly stringent rulings of the Fuel Administration, the War Industries Board and the Capital Issues Committee, and the position taken by the Department of Labor in classing building labor as non-essential. The most far reaching orders of the War Industries Board were those affecting the building industry. The zero hour for building came when pledges were required of all material dealers and licenses of the non-war construction section of the War Industries Board for all buildings over $2,500.

The release of building work has been more rapid beginning with a more liberal attitude toward housing projects, followed by the release of building under $10,000, the general removal of restrictions, and culminating in Mr. McAdoo's statement of Nov. 17 urging civil construction and instructing the Supervising Architect of the Treasury Department to proceed with government work, and then Mr. Baruch's order of Nov. 21 releasing all restrictions.

**Construction Essential to Normal Business Development.**—The present conditions in the building industry are similar to conditions before the war, but more acute. Costs of labor and material are still higher. The most favorable aspect of the situation lies in the increasing shortage of buildings of all types—constituting a potential demand for construction. Deferred building is part of the war debt, that is, it must be met before we can return to normal conditions. Construction is an essential industry and therefore a prerequisite to all normal business development. The natural inactivity of building in the fall and winter should give opportunity, in view of the shortage in all types of construction, for the gradual restoration of confidence in such investments, unretarded by fear because it does not come faster. The winter may also give those who are planning to build the opportunity for laying plans and choosing their materials.

**Unfavorable Factor in Building Outlook.**—The most unfavorable factor in the building outlook is the timidity of investment capital. This is a hang-over from pre-war conditions which still pervade finance. The effect of the war orders of the administration and the systematic discouragement of building by the Capital Issues Committee is still apparent. Another adverse factor is the restlessness of labor apart from the element of wages (since only 10 per cent of labor disputes in the building lines are over wages, the other 90 per cent being petty, jurisdictional or breach of contract), together with inefficiency due to government work and overtime standards. Transportation cannot be depended upon for efficient service and rates have increased to almost a prohibitive degree, although before the war 25 per cent of the carrying capacity of the railroads was devoted to building material. Finally fuel, although released, is high and difficult to obtain, for the building industry consumes 30,000,000 tons out of the 425,000,000 produced by the country.

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*From an address delivered Dec. 7 at the convention of the National Federation of Construction Industries.

Now these factors are grave and might weigh in other less essential industries, but in building they are offset first, by the necessity of immediate housing for a large percentage of the population who are suffering through the high cost of living induced by building shortage, and second, by the encouragement which the government is now giving building. Secretary McAdoo regards the revival of the construction industry as essential to the country's welfare in its transition from a war to a peace basis, and former Governor Hughes, at a recent meeting of the Academy of Arts and Sciences, has urged an immediate country wide survey of needed public construction.

**Government Construction Alone Will Not Bring Building Industry to Its Normal Condition.**—But builders who are far seeing and able to analyze the present situation realize that public construction alone will not bring the industry back to its normal position in the life of the nation. Government construction can only help as a transition measure, while private enterprise is slowly recovering its confidence and reabsorbing labor and materials. As an ultimate solution of the building prices, government construction alone will fail, because at most it can substitute but a small proportion of normal building; it will not relieve the present burden of taxation; and it will not supply buildings which bring reduction of rents and afford the necessary tools of industry.

On the whole, military and government housing construction has had an unfavorable influence on building. Government contracts have been let in large numbers. They have been let on a cost plus basis and they have been carried out without close supervision. Abnormal war requirements have set false precedents for the cost of materials and the cost and efficiency of labor. Continued government construction as a substitute for private enterprise will injure the industry, for the public work will absorb a fraction of our surplus labor and material and thus help to stabilize markets, it will maintain the present false standards which are now the greatest discouragement to private investment. Thus in the long run the total annual output of construction will not be caught up.

The remedy for these difficulties is the encouragement of private building which shall steadily and increasingly replace public construction and as rapidly as possible take over surplus labor and material and establish the industry on a sound economic basis.

**Government Co-operation Needed for Encouragement of Private Investment.**—The immediate problem, therefore, which confronts the building industry is to find a means of encouraging private construction. Two methods suggest themselves. First, the co-operation of the government should be secured, not only for the development of large public works, but more fundamentally in the encouragement of private investment. During the past year, from the time of the first restrictions on building until the day when the armistice was signed and rapid releases were made, the government, through a series of rulings and non-binding orders, carried on a vigorous publicity campaign designed to discourage all non-war construction. Now that the objects of the war are achieved and the time has come to build up the industry again, the government should through similar methods of publicity counteract the depressing effect which its war measures have had on capital, and thus hasten the return of normal conditions.

Aside from the benefits which will accrue directly to the building industry through the government's adoption of such a policy, will be its far reaching effect on the country as a whole. As a source of national revenue alone, the government would do well to restore the building industry by every means at its command. Before the war the construction of the country, including increased land values, because of such construction, paid more than one-half of the taxes of the nation, if County, State and Federal budgets are included.

Before the war the industry employed over 2,000,000 men, all tax members of society. Since the war a greater portion of the total annual output of construction has been deferred on account of government restrictions, causing the loss of a sum equal to the entire estimated savings effected by price fixing.

The government should encourage private enterprise as the only solution of the serious social problems which spring from the high cost of living and the restlessness of labor.

**Federation of Diverse Factors of the Industry.**—But the restoration of the building industry cannot be brought about through government encouragement of private investment alone. A second measure which it seems imperative to take in this complex period of readjustment is the organization of the many diverse factors of the industry through a federation, flexible and yet strong and far-seeing enough to deal with the problems which are common to all branches of the industry. The very complexity of these problems today are evidence of the need of such unity and strength and co-operative effort as federation alone gives.

While there is an under-supply of building extending back over a period of years, there is insufficient demand to form a satisfactory basis in order to keep the industry in normal condition. For this purpose construction should total about $250,000,000 per month. It presumably will be a government policy to allow each industry to solve its own problems free from government regulations. Industries which have been enjoying war profits and the benefits of organization through war activity are better able to solve their own problems than is the building industry under present conditions. Unless the building industry takes on more than normal activity and produces in addition to current requirements, during the next two or three years, an additional amount of building construction, equal to that which has been deferred, the country will remain in a state of arrested development.

**The Labor Situation.**—On a basis of an armed force of 4,000,000 men there are probably between 15,000,000 and 20,000,000 diverted from peace to war work. If the armed force is reduced to 1,000,000 men during the coming year there will be from 12,000,000 to 15,000,000 men free for the industries of peace. The maximum of labor shortage never exceeded between 1,000,000 and 2,000,000 men and at present there is little or no shortage.

**The Material Situation.**—While there is less than a normal supply of materials in the hands of manufacturers, there is an over-supply in the hands of the government which cannot be thrown on the market without breaking the market and throwing labor out of employment. Representatives of the War Industries Board estimated that the country was producing steel at the rate of 45,000,000 tons per year (on Nov. 1); that this was practically all used for war purposes. The first half of 1918 the steel industry produced 17,000,000 tons, or at the rate of 34,000,000 tons annually. It is estimated that France will not need over 8,000,000 tons during the coming year, if as much. The use and sale of the surplus output must be arranged for unless the steel industry is to go into a condition of depression with unfavorable effect on labor and with sympathetic effect toward general building depression. Building industry will never absorb steel at the former rate per cubic foot, because reinforced concrete construction has become popular and requires but one third the steel of ordinary steel construction, with a consequent saving of labor in steel production, transportation and erection.

On the wise solution of these intricate problems involving all branches of the building industry will depend the recovery which it makes in the period of reconstruction ahead. For their solution should be marshaled the best brains of the industry, through an organization which will give expression to all aspects of these problems and function adequately with the department of commerce of the government in working out a liberal and progressive policy for the development of the industry during the next few years.

## The Stone Industry in 1917

The total value of stone sold in the United States in 1917 was $82,215,617, according to statistics compiled by Mr. G. F. Loughlin, of the U. S. Geological Survey. This is an increase of 4 per cent over the value of that sold in 1916. This increase followed an increase of 6 per cent in 1916 and a decrease of 4 per cent in 1915. The quantity of stone sold in 1917 was approximately 82,800,000 short tons, a decrease of about 9 per cent from that sold in 1916. The increase in value in 1917 was due entirely to the greater value of limestone sold, as the total value of all other varieties of stone sold was less, the decrease ranging from 1 to 11 per cent. An increase of 12 per cent in the value of limestone was due to a large increase in the output of stone quarried for use as furnace flux—from 23,623,508 long tons, valued at $13,946,882, in 1916, to 25,574,146 long tons, valued at $18,679,213, in 1917.

Continued depression in the building industry in 1917, which affected the better grade of building stone of all kinds, caused a decrease of over 17 per cent in value, and of 30 per cent in quantity. The output for 1917 was 17,263,893 cubic feet, valued at $12,102,914, and that for 1916 was 24,754,742 cubic feet, valued at $14,677,808. The value of paving blocks sold in 1917 was $2,732,444, practically the same as in 1916. This sum represented an output of 48,907,677 blocks having an average value per 1,000 blocks of $55.87. Though figures showing the exact quantity produced in 1916 are not available, a close estimate, based on an exact knowledge of 87 per cent of the output, showed an output of 55,061,840 blocks, a decrease of 11 per cent. The value of both curbing and flagging decreased 13 per cent in 1917, that of stone for riprap decreased 31 per cent, and that of stone for rubble increased nearly 5 per cent. Crushed stone amounting to 40,285,377 short tons, valued at $29,065,509, was produced in 1917, a decrease of 7,790,204 tons (16 per cent) in quantity and $397,043 (1.3 per cent) in value. The average value was 72 cents per ton in 1917, an increase of 11 cents. The following tabulation shows the quantity and value of stone sold in the United States in 1917:

| | | | |
|---|---|---|---|
| Building stone | (cu. ft.) | 17,263,893 | $12,102,910 |
| Monumental stone | (cu. ft.) | 4,058,626 | 8,102,000 |
| Paving blocks | (number) | 48,907,677 | 2,732,000 |
| Curbing | (lineal ft.) | 3,698,275 | 1,402,980 |
| Flagging | (sq. ft.) | 3,027,115 | 356,327 |
| Rubble and riprap | (short tons) | 3,598,585 | 3,072,694 |
| Crushed stone | (short tons) | 40,285,377 | 29,065,509 |
| Furnace flux | (long tons) | 25,574,146 | 18,679,213 |
| Refractory | (short tons) | 1,573,573 | 1,607,743 |
| Manufacturing industries | (short tons) | 5,446,558 | 4,070,351 |
| Other uses | (short tons) | 1,299,887 | 1,023,013 |

The number of plants reporting operations in 1917 was 2,647, which was 388 less than in 1916. A large number of the small quarries were closed on account of scarcity of labor, increased cost of supplies, lack of local demand, and substitution of cheaper material. The increase in the cost of operation was 20 to 75 per cent, and the advance in the selling price was 20 to 50 per cent.

**State Governors Asked to Submit Construction Programs.**—The War Labor Policies Board on Dec. 7 sent telegrams to governors of all the states urging the necessity of developing public works during the period of demobilizing. The governors were asked to have complete data on construction projects available at the annual conference of governors which opened at Annapolis, Md., Dec. 16. Information received by the Board from mayors of large cities in response to similar requests indicates that approximately $300,000,000 worth of public construction stopped on account of the war can be resumed as rapidly as men and materials are available.

## Engineers' License Laws

The various state laws, existing and proposed, for licensing engineers are summarized in the preliminary report of the Committee on Legislation of the American Association Engineers, which was appointed last September to gather information on the subject and to draw up a standard license law. The report appears in the December Monad, from which the following is abstracted:

### Existing License Laws.

LOUISIANA. Passed in 1908. Provides for examination and license of surveyors and civil engineers by Board of Examiners appointed by the Governor. Fee and registration, $12.

WYOMING. Licenses engineers and surveyors in matters relating to water conservation and irrigation work. Examining Board consists of state engineer and two other engineers appointed by the Governor. Fee, $5.

ILLINOIS. Passed in 1915. Provides for the licensing of all persons practicing structural engineering. Defined as follows: "Any persons engaged as principal in the designing and supervision of construction of structures designed solely for the generation of electricity or for the handling of coal, cement, sand, gravel, or similar materials, elevators, manufacturing plants, docks, bridges, blast furnaces, rolling mills, gas producers and reservoirs, water tanks, sanitary works as applied to the purification of water, or plants for waste and sewage disposal, roundhouses, railroad shops, pumping stations, or power houses shall be considered as structural engineers."

Board of five examiners appointed by the Governor. Plans to be stamped with license seal of engineer. Reciprocity arrangement with other state licensed engineers. Fee and registration, $51. Annual fee, $10.

Although entitled "a structural engineers' law" it really covers quite a comprehensive field of civil engineering. The law was passed through the efforts of an energetic and able committee of the Western Society of Engineers.

FLORIDA. Passed in 1917. This law covers the practice of civil engineering. It is almost identical in form with that suggested by the committee of the American Society of Civil Engineers and which is outlined below. Examination and registration fee, $25. Annual fee, $5.

Other states and countries having engineers' or surveyors' license laws of various degrees of requirement are: California, Idaho, South Dakota, Canada, and City of Mexico.

### Proposed Laws.

NEW YORK. In 1910 or 1911 bills were introduced in the New York legislature by the Technical League for licensing engineers. Objection to the form and division of opinion among engineers defeated these measures. The agitation led to the appointment in 1910 of a Committee on Legislation by the American Society of Civil Engineers. The Board declaiming: "That it was the sentiment of the Board that the A. S. C. E. use its influence in the proper formulation of legislation affecting the practice of engineering."

The committee submitted a proposed form of law which was afterward, in 1911, slightly altered by the Board, who presented the same with the prelude: "The Board of Direction of the A. S. C. E. does not deem it necessary or desirable that civil engineers be licensed in any state. If, notwithstanding, any state legislature deems statutes covering the practice of civil engineering desirable, the following draft is recommended: (Synopsis of this is given below.)

PENNSYLVANIA. In 1909 a bill for licensing was introduced in the legislature. It was crude and ridiculous, and deserved the defeat it received. In 1913 a commission of engineers appointed to investigate reported to the Governor on March 2, 1916. "Does not recommend all engineers to pass an examination and be registered. Recommends regulation of practice in state and municipal service." The commission formulated a bill similar to the A. S. C. E. form, covering very comprehensively many specific lines of engineering. The bill was not introduced to our present knowledge.

IOWA. In 1916 a carefully drawn bill for the registration of civil engineers failed to pass for want of energetic support of the engineers. The bill contained some novel features but which are worthy of serious consideration.

OHIO. Introduced in 1917. Failed to pass.

COLORADO. A bill formulated by the Colorado Secretary of Civil Engineers is submitted to engineers for suggestions to the committee by W. L. Draper, 2381 Clermont street, Denver, Colo.

MINNESOTA. The Minnesota State Engineers and Surveyors' Society has appointed a committee to report upon the questions of the licensing of engineers. Geo. L. Wilson, Engineer, M. of W., Minneapolis Street Railway Company, is Chairman.

MICHIGAN. A bill has been formulated for the registration of civil engineers to go into effect August, 1919.

### Synopsis of Law Suggesterd by Am. Soc. C. E.

The essentials for a satisfactory engineers' license law, as set forth in the form suggested by the American Society of Civil Engineers and as incorporated in the Florida act, and to a modified degree in all other existing acts, are as follows:

1. An exact definition of civil engineering as illustrated by a statement of specific works covered.
2. The appointment of a Board of Examiners, usually five, and made by the Governor. Requirements for membership of the Board. Appointment of a Secretary.
3. Minimum requirements from candidates in qualifying for examination. Six years' experience, one of which is in responsible charge. Two years' allowance for graduate of approved technical school. It has been suggested that a minimum educational standard be a preliminary requirement.
4. Exemptions from examination. Those in actual practice prior to the act. (To avoid an ex post facto law.) Those licensed in other states having equal requirements. It is suggested that no additional fee be required of such parties other than a nominal registration fee. Consulting engineers for licensed engineers. Also sufficient time for engineers of other states to permit them to register without interruption of work. (See Louisiana Law.)
5. Reciprocity with other states.
6. Conditions and limitation of the examination.
7. Penalty for violation of the act. It has been suggested also that a license is required to qualify an expert witness and that no legal collection for engineering fees be granted unless licensed.
9. Required seal on plans.
10. Investigation and prosecutions.

The Board to be active and responsible for this burden.

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**Railway Improvements to Cost $900,000,000 Proposed.**—A program of railroad improvements involving an outlay of $909,000,000 for this year and 1919 is to be carried forward by the Federal Railroad Administration, according to an announcement made by former Director General McAdoo. The items of this total do not include additional equipment.

# Calculation of Charge in Blasting

Methods of determining the amount of explosive to be used under various conditions of blasting are described by Mr. Oliver Bowles in a bulletin, "Rock Quarrying for Cement Manufacturing," issued recently by the U. S. Bureau of Mines. The following notes are abstracted from the bulletin:

When churn-drill methods are first tried, a common mistake is to make the burden too heavy. It is then impossible to place enough explosive in the drill holes to effectually shatter the mass of rock blocked out. Blasting in churn-drill holes, as practiced in many quarries at the present time, involves large costs for drilling and explosives for a single shot. Where the cost of one shot may reach several thousands of dollars, failure of the shot results in considerable loss. Success in blasting depends largely on the proper proportioning of the charge, consequently a careful and systematic method of determining the charge should be followed.

The best method is to calculate the tonnage of rock to be moved and to proportion the charge accordingly. The tonnage in short tons may be easily calculated by multiplying together the length, breadth, and height, in feet, of the mass to be moved, multiplying this product by the weight of a cubic foot of the rock, and dividing by 2,000. An average weight per cubic foot of solid limestone is 168 lbs. If a reliable determination has been made of the weight of the rock in any quarry, the figure obtained may be used in place of 168.

If, for example, the length of the mass of rock to be shot down is 200 ft., the width 25 ft., and the height 80 ft., the approximate tonnage would be

$$\frac{200\times25\times80\times168}{2000} = 33{,}600 \text{ tons.}$$

The amount of explosive required for a given tonnage depends on the physical properties of the rock, such as hardness, soundness, the attitude of the beds, and also on the type of explosives employed. As a rule, 1 lb. of the explosive ordinarily used in churn-drill holes is sufficient for breaking 4 or 5 tons of rock. An exact figure can be determined only by experience. If the charge is calculated on a basis of 1 lb. of 40 per cent "straight" nitroglycerin dynamite or nitrostarch blasting powder for each 5 tons of rock, and the rock is not sufficiently shattered either the proportion of explosive should be increased or a higher grade should be employed. If, on the other hand, a V-shaped mass is blown out and the rock is hurled to a great distance, subsequent charges may be reduced in size or a weaker explosive may be substituted.

The amount of explosive as determined on some such basis may be proportioned among the various drill holes. Even when all the holes are of equal depth, it may be wise to vary the charges. In blasting a heavy toe, or a corner,

TABLE I.—NUMBER OF TONS* OF LIMESTONE PER FOOT OF DRILL HOLE FOR VARIOUS SPACINGS AND BURDENS

| Burden of drill holes, Feet. | Spacing of drill holes, feet. | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. |
| 5 | 2.08 | 2.52 | 2.92 | 3.36 | 3.78 | 4.20 | | | | | | | | | | |
| 6 | 2.52 | 3.02 | 3.52 | 4.03 | 4.53 | 5.04 | 5.54 | | | | | | | | | |
| 7 | 2.94 | 3.52 | 4.11 | 4.70 | 5.29 | 5.88 | 6.47 | 7.05 | | | | | | | | |
| 8 | 3.36 | 4.03 | 4.70 | 5.37 | 6.04 | 6.72 | 7.39 | 8.06 | 8.73 | | | | | | | |
| 9 | 3.78 | 4.54 | 5.29 | 6.04 | 6.80 | 7.56 | 8.31 | 9.07 | 9.82 | 10.58 | | | | | | |
| 10 | 4.20 | 5.04 | 5.88 | 6.72 | 7.56 | 8.40 | 9.24 | 10.08 | 10.92 | 11.76 | 12.60 | | | | | |
| 11 | | | 6.46 | 7.39 | 8.31 | 9.24 | 10.16 | 11.08 | 12.01 | 12.93 | 13.86 | 14.78 | | | | |
| 12 | | | | 8.06 | 9.07 | 10.08 | 11.08 | 12.09 | 13.10 | 14.11 | 15.12 | 16.13 | 17.13 | | | |
| 13 | | | | | 9.82 | 10.92 | 12.01 | 13.10 | 14.19 | 15.28 | 16.38 | 17.47 | 18.56 | 19.65 | | |
| 14 | | | | | | 11.76 | 12.93 | 14.11 | 15.28 | 16.46 | 17.64 | 18.82 | 19.99 | 21.16 | 22.34 | |
| 15 | | | | | | | 13.86 | 15.12 | 16.38 | 17.64 | 18.90 | 20.16 | 21.42 | 22.68 | 23.94 | 25.20 |
| 16 | | | | | | | | 16.13 | 17.47 | 18.81 | 20.16 | 21.50 | 22.84 | 24.19 | 25.54 | 26.88 |
| 17 | | | | | | | | | 18.56 | 19.99 | 21.42 | 22.84 | 24.28 | 25.70 | 27.13 | 28.56 |
| 18 | | | | | | | | | 19.65 | 21.16 | 22.68 | 24.19 | 25.70 | 27.22 | 28.72 | 30.24 |
| 19 | | | | | | | | | 20.74 | 22.34 | 23.94 | 25.53 | 27.13 | 28.73 | 30.32 | 31.92 |
| 20 | | | | | | | | | | 23.52 | 25.20 | 26.88 | 28.56 | 30.24 | 31.92 | 33.60 |
| 21 | | | | | | | | | | 24.69 | 26.46 | 28.22 | 29.99 | 31.75 | 33.51 | 35.28 |
| 22 | | | | | | | | | | | 27.72 | 29.57 | 31.41 | 33.26 | 35.11 | 36.96 |
| 23 | | | | | | | | | | | 28.98 | 30.91 | 32.84 | 34.77 | 36.70 | 38.64 |
| 24 | | | | | | | | | | | | 32.25 | 34.27 | 36.29 | 38.30 | 40.32 |
| 25 | | | | | | | | | | | | 33.60 | 35.70 | 37.80 | 39.90 | 42.00 |
| 26 | | | | | | | | | | | | | 37.12 | 39.31 | 41.49 | 43.68 |
| 27 | | | | | | | | | | | | | 38.55 | 40.82 | 43.09 | 45.36 |
| 28 | | | | | | | | | | | | | | 42.33 | 44.68 | 47.04 |
| 29 | | | | | | | | | | | | | | 43.84 | 46.28 | 48.72 |
| 30 | | | | | | | | | | | | | | | 47.88. | 50.40 |

*Rock assumed to weigh 168 lb. per cubic foot.

heavier charges may be required for certain holes than for others.

Usually the drill holes are not of equal depth because the surface is curved, sloping, or irregular. Under such conditions it is necessary to calculate the charge for each drill hole. To simplify such determinations, Table I has been compiled, showing the number of tons of rock for each foot of drill hole for various spacings and burdens. The figures in the horizontal line at the top represent the number of feet of spacing, and in the column at the left, the number of feet of burden. Thus, by following to the right the line for any particular burden until the column under the desired spacing is reached, the figure found will represent the number of tons of rock that must be moved for each foot of drill hole. If, for example, the burden is 14 feet and the spacing 11 feet, 12.93 tons of rock must be moved for each foot of drill hole. By multiplying this quantity by the depth of the hole in feet, the total tonnage for which explosive must be provided in this hole may be determined.

Obviously, the proper spacing and burden for a given size of drill holes may be determined in the same way. Thus it may be found that when the calculated amount of explosive is placed in a 5⅝-inch drill hole the charge is too low in the hole to break the upper rock effectually. The difficulty may be overcome by separating the charge into two parts with intermediate stemming, by using a larger amount of a lower grade explosive, by increasing the burden and spacing of the drill holes and increasing the charge accordingly, or by reducing the diameter of the drill holes. When the explosive would fill the bore hole too high, it may be a good plan to chamber the hole. If the drill holes will not hold enough 40 per cent strength explosive to properly break the bottom, it is better to use 60 per cent strength explosive in the bottoms of the holes.

In order to judge the proper size of drill holes to use, the shot firer should know the number of pounds of explosive that can be placed in a drill hole of a given size. Table II, compiled by one explosives firm,† indicates the quantity of various types of explosives that can be placed in each foot of drill holes of various sizes when the cartridges are slit and the charge well tamped.

TABLE II—QUANTITY OF EXPLOSIVE PER FOOT THAT CAN BE PLACED IN DRILL HOLES OF VARIOUS SIZES.

| Diameter of drill hole. In. | Galatin dynamite. Lb. | Straight nitro-glycerin dynamite. Lb. | Low freezing ammonia dynamite. Lb. | Extra ammonia dynamite. Lb. |
|---|---|---|---|---|
| 3 | 4.25 | 3.75 | 3.60 | 3.72 |
| 3½ | 5.68 | 5.10 | 4.89 | 5.07 |
| 4 | 7.55 | 6.60 | 6.33 | 6.62 |
| 4½ | 9.35 | 8.40 | 8.06 | 8.38 |
| 5 | 11.80 | 10.50 | 10.08 | 10.35 |
| 5⅝ | 14.94 | 13.20 | 12.53 | 13.00 |
| 6 | 17.00 | 15.00 | 14.40 | 14.90 |

The conditions of a shot may be varied by changing the amount of the charge, by changing the type of the explosive, and by varying the spacing and burden of the drill holes. Hence the problem is complicated, and good judgment and long experience are required on the part of the shot firer before maximum efficiency is attained.

**Complete Electrification of Illinois Central R. R. in Chicago Proposed.**—The committee on railway terminals of the City Council of Chicago is considering an ordinance providing for the electrification of the entire service of the Illinois Central R. R. inside the limits of the city. The complete plan—electrification is only one portion of it—calls for the expenditure of several hundred millions of dollars for improvements. These include a new $20,000,000 passenger station, extension of Grant Park southward, widening, relocation, and extension of Indiana av., widening and extension of East 12th st., construction of five bathing beaches, creation of a new harbor district to be known as harbor district No. 3, and reclamation of lands by the railway terminal commissioners and the Illinois Central Co.

# Excavation Methods and Equipment on Construction of 8½ Mile Niagara Power Canal

The Hydro-Electric Power Commission of Ontario is now engaged in constructing an 8½-mile canal, which will divert a flow of 10,000 second feet of water from Niagara Falls, and enable 300,000 HP. to be developed. This is one of the largest civil engineering enterprises now in progress in either Canada or the United States. Its estimated cost is $25,000,000 and, although begun in 1917, it will not be complete until 1921 or 1922, despite the fact that work is being carried on day and night. An interesting account of this work appears in the December Mine and Quarry, to which we are indebted for the matter that follows.

**General Features of Canal.**—The canal gradient is planned for 1.1 ft. per mile, which will give an estimated velocity of 6 to 7 ft. per second. The cut is 162 ft. wide in earth, with slopes of 1½ to 1; and 48 ft. wide in the rock sections, with vertical sides, the overburden being sloped 1½ to 1. The water will flow to a depth of 35 ft. in the rock portions of the channel, and will wet the earth section to a vertical depth of about 26 ft., with a mean water line width of 84 ft. The bottom of the canal will be 34.6 ft. wide in earth. From Montrose, where the canal leaves the Welland River, the first 8,000 ft. are in earth. The remainder of the canal is in rock, except for a section near the Whirlpool, which is in earth for about 2,000 ft. The total amount of earth to be excavated is 11,000,000 cu. yd., and of rock, 4,000,000 yd. The Hydro Electric Power Commission has acquired a wide right-of-way for this work, with sufficient room to build two additional canals. Preliminary surveys for this enterprise were made as early as 1914, and diamond drill borings were employed along the proposed line to determine accurately the nature of the rock formation. It was not until early in 1917, however, that actual construction was begun. The work is being performed by forces of the commission on its own account, and has been pushed with great vigor during the war. No diminution of effort has resulted with the conclusion of hostilities, as it is felt that the industrial development of this section of Ontario depends on the additional power which this undertaking will provide.

**Earth Removal—Heavy Equipment.**—The work of construction is proceeding on the river section and on the three land or canal sections simultaneously. In the river, 2,000,000 yd. of earth are being removed by means of a Lidgerwood cableway, operating a 3-yd. clamshell bucket, and by a 3-yd. dipper dredge. The cableway has a span of 800 ft., with a head tower 80 ft. high and a 60-ft. tail tower. The dredge is handling the 4,400 ft. section nearest the Niagara River, loading the material on scows which are hauled out into deep water in that stream. The river cut is 40 ft. wide and will be 30 ft. deep.

Due to the accessibility and low cost to the commission of electricity, this form of power is being employed for all possible purposes. Electric shovels are employed for excavation, and twelve 50-ton electric locomotives were designed and built especially for this work. These receive their power from an overhead trolley, carried 7 ft. from the center of the track by portable supports, so as to provide clearance for shovels, cranes, etc.

**Large Electric Shovels.**—Due to the depth of the cut, ranging from 50 to 145 ft. (at one point) and the prevalence of quicksand, the use of large, powerful excavators, capable of handling the work on a single lift was decided on. Perhaps the most impressive machines on the job are the three huge Bucyrus electric shovels, type "225-B." These weigh 375 tons each, develop 800 HP., and are equipped with 90-ft. booms and 8-yd. dippers. The motors are Westinghouse type M.A., 440-volt A.C., 25 cycle, with Cutler-Hammer control. Transformers, mounted on the shovels, receive line current at 4,000 volts and step it down to working tension.

Figure 1 shows one of these shovels, which is removing 85,000 cu. yd. of earth per month, loading cars at an average height of 86 ft. above the shovel rails and working one 10-hour shift and no Sundays. Where the earthwork is completed, the 8-yd. dippers will be replaced with 5-yd. dippers for handling rock. Three other electric shovels are in use of the Bucyrus 103-C, 110-ton pattern, developing 350 HP. and having 4½-yd. dippers and special booms for 19½ ft. loading in the clear. These are all built of steel throughout. There are numerous other shovels and excavators, some operated by steam and others by electricity.

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†See E. I. Du Pont de Nemours & Co. catalogue: Explosives for quarry blasting, 1915, p. 15.

**Rock Removal—Channeling.**—The rock encountered is Niagara limestone, and is overlain with fine drift ranging from 0 at the lower end to 40 ft. in depth at the upper.

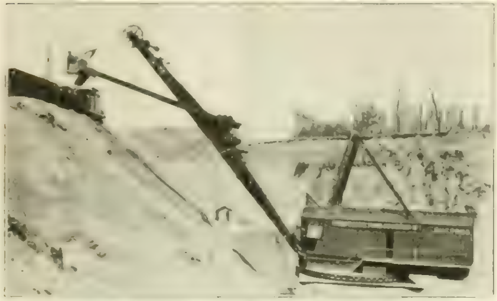

Fig. 1—Electric Shovel With 90 ft. Boom and 8 yd. Dipper, Loading Cars 86 ft. Above Shovel Rails.

Work was therefore begun at the gorge or forebay end. In order to avoid shattering the rock walls, with subsequent rapid weathering, and to provide for a smooth surface, offering a low frictional resistance to the flow of water in the canal, the use of channeling machines was decided upon. Twenty Sullivan duplex "VW-61" channelers, air operated, are in use. These have two 8-in. chopping engines striking alternately, and capable of cutting to a depth of 20 ft. They take air at 100 lb. pressure and maximum efficiency is secured by the use of special reheaters, mounted on the frames of the machines. This is the same type of channeler as those recently employed on the Welland Canal, except that the latter were steam machines. These channelers are shown in operation in Fig. 2. Ten machines are at work on each side of the canal, on continuous track, in batteries. This arrangement is a common one in building stone quarries, especially in the Bloomington-Bedford district of Indiana, but is seldom seen on a construction job. It secures an absolutely straight cut on the surveyed line, and a better rate of progress than if the channelers were placed scattering along the canal. For one thing, the sludge or mud at the bottom of the cut is kept constantly agitated, and does not have a chance to settle and form a cushion. An element of competition is also brought into play between the machines on the two sides of the canal.

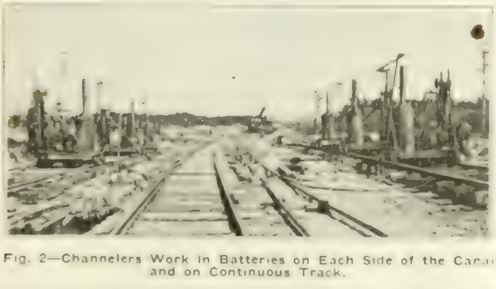

Fig. 2—Channelers Work in Batteries on Each Side of the Canal and on Continuous Track.

The channelers are cutting at the average rate of about 200 sq. ft. per 10-hour day per machine, which is good progress in this stone, considering the depth of the cut (20 ft.): To eliminate delay due to lack of sharp steel, a portable blacksmith shop was built, and runs on tracks laid on the center line of the canal. In this shop on wheels a Sullivan all-hammer drill sharpener is used to sharpen the three-piece gage steel for the channelers. The importance to rapid and efficient channeling of an adequate supply of steel, with bits of proper shape, angle of cutting edge and of uniform gage, properly tempered, cannot be over-estimated.

**Rock Drilling.**—For drilling the rock between the channeler cuts, 25 Sullivan Hy-speed hollow piston drills are employed, with 3⅝-in. cylinder diameter. These machines employ 1⅜-in. hollow steel. The advantage derived from the use of hollow steel is, that for each stroke of the piston, the bit has a clean cutting surface, the cuttings being blown out of the hole as rapidly as they are made. In this way none of the force of the blow is absorbed in grinding up the cuttings. This is very evident to the onlooker, for when one compares the cuttings accumulated around the collar of the hole in which hollow steel is being employed, one will note that they are very much coarser than the cuttings around the collar of a hole of a drill using solid steel. These drills are mounted on Lewis hole tripods, which permit the drill to be slid along the front bar, off the steel.

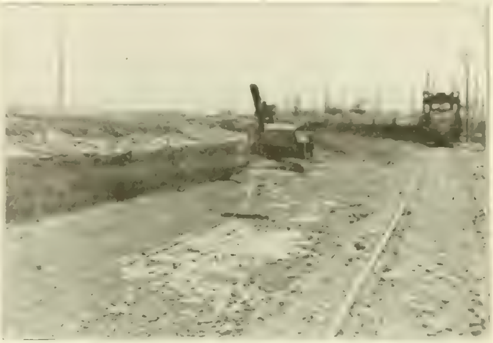

Fig. 3—Niagara Power Canal at Station 443 on Nov. 14, 1918.

With these drills, holes from 9 to 14 ft. deep are put in rows in the usual manner, spaced 7 ft. each way. The number of holes shot at one blast is, however, unusual, ranging as high as 1,200 or even 2,000. The holes are first sprung with from 3 to 7 sticks of powder, then reloaded with 25 to 40 sticks of dynamite, running from 40 to 60 per cent strength. In one of these shots, in the forebay, 30,000 lb. of powder were used. An ingenious method of connecting up the holes was worked out to insure that all were exploded. A current of low relative voltage but large amperage was used, and the firing was done with a single switch.

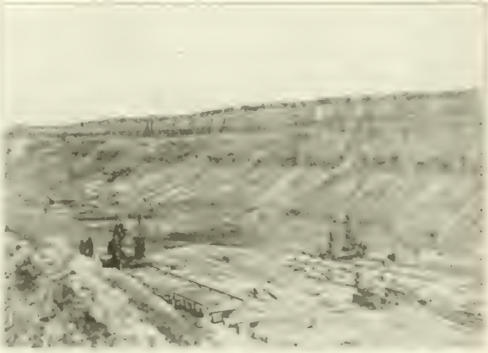

Fig. 4—Channelers Working in First Cut at Station [illegible]25.5.

Sullivan air tube rotators are employed for drilling large boulders, trimming up walls, etc. They will also be used, it is planned, for the excavation of the wheel pit. Sullivan 5-in. submarine rock drills are also in use, mounted on towers for handling long steel, to drill some of the deep holes in the rock section. It is expected that the broken nature of the rock will necessitate lining the walls with concrete below water line.

**Compressed Air Plants.**—The Sullivan drills, as well as the channelers, are operated by compressed air at 100 lb. pressure, supplied from two central multi-unit compressor plants. One of these is near the Whirlpool, and the other at Montrose, at the river end of the canal proper. The first plant contains eight Sullivan angle compound air compressors, size 20x12x14 in., with a free air capacity of 1,100 cu. ft., or about 8,800 ft. in all. At Montrose four similar units are installed. These machines are operated by short belt drive from alternating current electric motors, and are equipped with total closure unloading devices on the inlet openings. An automatic relief valve is also provided on the high pressure cylinder, which pumps out air remaining in the intercooler or high pressure cylinder during no load periods, thus further economizing power. Three-pass, counter current intercoolers are employed, and provide high efficiency. The flexible capacity afforded by these two plants permits economical operation at all load factors. After-coolers are in use, and reheaters will probably be set up near the drills during the winter. The main air line is 10 in. in diameter.

Two Sullivan drill sharpeners of the all-hammer type, also air-operated, maintain an ample supply of sharp steel for the rock and hammer drills.

**Muck Disposal.**—Much of the rock excavated is suitable for use as aggregate for concrete on the linings, etc., and for this purpose a portion of it is crushed in a 250-HP. 60x84-in. Traylor jaw crusher. Along the river section, the spoil is dumped on the bank on the head side of the cableway. Along the canal, however, the rock and earth muck are loaded by the shovels into 20-yd. automatic Western side-dump cars of which the commission owns 150. A large dumping area is provided at St. David's, not far from the center of the work, and the spoil is hauled to the dump on the construction railroad which parallels the line of the canal. This railroad is standard gage, and double tracked. It will eventually total 40 miles of single track.

Incidental construction work on this big enterprise is a large item in itself, including, as it does, 10 concrete arch bridges, three of them carrying railroads, and a reinforced concrete intake structure, calling for extensive cofferdam work in the Niagara River. An elaborate crushing, storage, conveying and concrete mixing plant is also a feature.

Sir Adam Besk is chairman of the Hydro-Electric Power Commission of Ontario, Frederick A. Gaby, chief engineer, and Henry G. Acres, hydraulic engineer. Mr. J. B. Goodwin is works engineer in charge of construction, with G. H. Angell as general superintendent and A. C. D. Blanchard as field engineer, and R. T. Gent as electrical and plant engineer.

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**Placement of Army and Navy Technical Men.**—Technical men of the Army and Navy released from active service are being registered by the Professional Division of the United States Employment Service, and placed in touch with those employers who can best make use of their services. The Professional Division deals only with those men who are well equipped by education and experience in their particular lines of work. The record of each man is carefully investigated before registration is permitted. Many university graduates in mechanical, electrical and civil engineering, and in chemistry, and other technical men with several years of practical experience, have already been registered. The Professional Division has its New York office at 16 E. 42d St. Employers seeking men are asked to inform the Division of the precise nature of the positions which they have available. Only those men who are well qualified to fill such positions are referred to the employer.

# President Wilson on the Railway Problem

In his address to Congress, Dec. 2, President Wilson urged Congress to take immediate action relative to the railways. He said:

The question which causes me the greatest concern is the question of the policy to be adopted toward the railroads. I frankly turn to you for counsel upon it. I have no confident judgment of my own. I do not see how any thoughtful man can have who knows anything of the complexity of the problem. It is a problem which must be studied—studied immediately and studied without bias and prejudice. Nothing can be gained by becoming partisans of any particular plan of settlement.

It was necessary that the administration of the railways should be taken over by the Government so long as the war lasted. It would have been impossible otherwise to establish and carry through under a single direction the necessary priorities of shipments. It would have been impossible otherwise to combine maximum production at the factories and mines and farms with the maximum possible car supply to take the products to the ports and markets; impossible to route troops shipments and freight shipments without regard to the advantage or disadvantage of the roads employed; impossible to subordinate, when necessary, all questions of convenience to the public necessity; impossible to give the necessary financial support to the roads from the public treasury. But all these necessities have now been served, and the question is, what is best for the railroads and for the public in the future.

The present law does not permit the use of the revenues of the several roads for the execution of such plans except by formal contract with their directors, some of whom will consent, while some will not, and therefore does not afford sufficient authority to undertake improvements upon the scale upon which it would be necessary to undertake them. Every approach to this difficult, subject-matter of decision brings us face to face, therefore with this unanswered question; what is right that we should do with the railroads, in the interest of the public and in fairness to their owners?

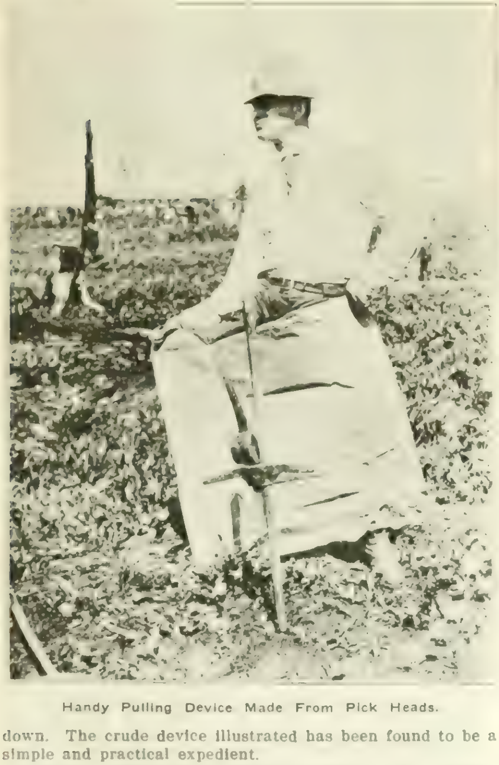
Let me say at once that I have no answer ready. The only thing that is perfectly clear to me is that it is not fair either to the public or to the owners of the railroads to leave the question unanswered and that it will presently become my duty to relinquish control of the roads, even before the expiration of the statutory period, unless there should appear some clear prospect in the meantime of a legislation solution. Their release would at least produce one element of a solution, namely, certainty and a quick stimulation of private initiative.

I believe that it will be serviceable for me to set forth as explicitly as possible the alternative courses that lie open to our choice. We can simply release the roads and go back to the old conditions of private management, unrestricted competition, and multiform regulation by both state and federal authorities; or we can go to the opposite extreme and establish complete Government control, accompanied, if necessary, by actual Government ownership; or we can adopt an intermediate course of modified private control, under a more unified and affirmative public regulation and under such alterations of the law as will permit wasteful competition to be avoided and a considerable degree of unification of administration to be effected, as for example, by regional corporations under which the railways of definable area would be in effect combined in single systems.

The one conclusion that I am ready to state with confidence is that it would be a disservice alike to the country and to the owners of the railroad to return to the old conditions unmodified. Those are conditions of restraint without development. There is nothing affirmative or helpful about them. What the country chiefly needs is that all its means of transportation should be developed, its railways, its waterways, its highways, and its countryside roads. Some new element of policy, therefore, is absolutely necessary—necessary for the service of the public, necessary for the release of credit to those who are administering the railways, necessary for the protection of their security holders. The old policy may be changed much or little, but surely it cannot wisely be left as it was. I hope that the Congress will have a complete and impartial study of the whole problem instituted at once and prosecuted as rapidly as possible. I stand ready and anxious to release the roads from the present control and I must do so at a very early date if by waiting until the statutory limit of time is reached I shall be merely prolonging the period of doubt and uncertainty which is hurtful to every interest concerned.

## Device for Pulling Drive Bar from Bore Hole

When putting down bore holes for blasting ditches, stumps, boulders or other purposes, it is sometimes a problem how to get out the drive bar after sledging it down. The crude device illustrated has been found to be a simple and practical expedient.



Handy Pulling Device Made From Pick Heads.

It will be noted that it consists merely of two ordinary railroad eye picks. The one in horizontal position affords a very good hold and leverage for pulling. If it is an octagonal bar, it can be turned or twisted by using the horizontal pick as a handle. If man power is not sufficient to pull or twist the bar out, one can use a hammer on the under side of the horizontal pick and drive it out, for the pick in vertical position will hold the other one in place so firmly that it will stand either pulling, driving or hammering.

**Bill Before Congress for $20,000,000 Canal in New Jersey.** A bill has been introduced in Congress to authorize the War Department to construct the proposed New Jersey link of the intercoastal canal. The total cost of the project would be $20,000,000, the bill provides, and the initial appropriation called for is $1,000,000.

# Today's Railroad Problem

By THEODORE P. SHONTS
President Interborough Rapid Transit Company

The purpose of the following observations is simply to express a point of view on today's Railroad Problem in the light of certain general principles.

President Wilson has stated frankly that he has no definite solution of the problem, and has left it to Congress. We may assume, I think, that he also hopes for full expression of views from the people.

I do not approach this problem as a banker or as a trustee for railroad investments. If I did, my chief concern would necessarily be to safeguard the trusts committed to my care.

As a citizen, however, with many years of experience in railroading and with a special experience in a plan of working with municipal government in transportation problems along lines which may offer a suggestion, I shall try to summarize the railroad situation as I see it.

I agree heartily with President Rea, of the Pennsylvania, that we must take government control as now in effect as a fact—and let that be our point of departure. And we must agree that the present system of operation has in it certain merits which must never be sacrificed. Most of them are merits that may exist under either private or government ownership and operation. Most of them, indeed, embody reforms for which railroad officers have clamored these many years.

First, and foremost, the Sherman law is out of business. He was tossed out of the window by Mr. Fairfax Harrison and the Railroad War Board as soon as war was declared; but President Wilson and Mr. McAdoo chloroformed and embalmed him on the 28th of last December.

Let us briefly suggest the other obvious blessings of the present regime:

1. The pooling of equipment and terminals.
2. The elimination of unnecessary trains and duplicated service.
3. The more economical loading and routing of freight.
4. The unification of passenger ticket offices.
5. The elimination of the frills of the business, such as observation cars for which no adequate fare was paid, etc.
6. The frank recognition of the necessity on the part of government, which adds to the expenses of operation, to find the increased rates and fares with which to pay those expenses; and,
7. The assertion of the right of the Federal Government to control the railroad situation as a whole in the national interest, in spite of conflicting state laws and obstructive state commissions.

These are great gains, and it is the duty of every railroad man to see to it that they are brought clearly to public attention. We must face the fact very frankly that the decision of this momentous issue is absolutely in the hands of the public. The public must take one of two broad policies.

It may prove profitable to sum up the factors constituting the two horns of the dilemma, one of which our nation must choose as its ultimate policy.

As one with practical railroad experience and as an observer of government operation throughout the world, I am convinced that the most economical operation can be attained under private ownership. And the gains we have obtained from government operation can all be retained under private ownership.

The great fact about government operation is the inevitable tendency toward extravagance and inefficiency. If the deficit from operations can always be made up out of taxation, if there is to be no reward for economy and forethought, it is impossible to expect careful watchfulness over expenditures.

The supreme test which we in this country must apply to our plan of dealing with this whole question must be this: which plan will provide the necessary transportation at the lowest possible cost?

This means that we must not alone make the best and most economical use of existing facilities, but we must provide the new facilities needed for the future development of our country.

We cannot here view the question as one might in England or France, where the necessary railroads are already built.

How are we to develop our existing roads, and how are we to build our new railroads? The heart of the problem is this: Shall it be by the log-rolling and pork-barrel methods under which we have developed our post offices, our rivers and our harbors, or shall it be by offering reasonable reward to those who by prudent forethought and initiative exert their imaginations and spend their money in developing the country?

As citizens, we cannot consider the railroads being returned to private owners merely for the reason that immediate return would redound to the benefit of large holders of the securities in some of the companies.

Any plan of returning these properties to private owners must contemplate three general propositions:

1. That a fair return may be paid upon existing investment.

3. That railroads must compete for capital in the money properties to attract the necessary capital with which to develop existing lines and to build new lines; and

3. That rainlroads must compete for capital in the money markets of the world, and must, by the same token, pay for that capital with some regard to the risk.

It has been suggested that the nation might adopt some such course with reference to railroads as is employed by New York City in its contracts with the subway and elevated. The cardinal point in those relations is that the city provides a large portion of the capital, but agrees that a fair return upon the private capital employed shall be earned and paid before the city's investment gets its return. After both sides have earned a fair return, the remaining profits are to be divided equally.

Such a plan is advantageous where there is an assured traffic. But there is grave question whether that plan would have resulted in such daring statesmanship as was embodied in the building of the Great Northern by Mr. Hill, the cutting across Salt Lake by Mr. Harriman, the building of the N. Y., P. & N. by Mr. Cassatt, or the construction of the Florida East Coast by Mr. Flagler.

The cardinal thought is this: that if we are to escape not only the bureaucracy, extravagance, and dead-level of Government ownership and operation, but also the political risk involved in the creation of a new and gigantic class of Government employees, we must be willing that some men who exercise energy, daring and prudence shall receive some fair measure of reward for their effort. In other words, we must recognize that it is no crime to make money in railroad building, if the money is made honestly and fairly.

If this principle is not to be recognized, the money for future railroad development simply cannot be obtained under private ownership. To return the properties to their present owners without recognition of that principle simply means that the tendencies of a year ago will be revived—and inevitable bankruptcy or government ownership will again stare the railroads in the face.

If this principle of permitting capital to earn sufficient reward to attract the means for normal future railroad development is recognized, my observation is that the principle will be made concrete in some such form as the following:

1. A plan of government regulation which will be scientific and not political; which will apply the same point of view to approving rates as to approving the chemical composition of a steel rail.

2. Concentration in the regulating authority which adds to the expenses of the roads of responsibility for the rates with which those expenses must be met.

3. Provision that initiation of rates shall be in the hands of the carriers; that rates may not be suspended, except upon complaint and after a hearing, and that final decision must be made within sixty days.

4. Establishment by Congress itself of the fundamental principles to govern the reasonableness of rates, such principles to include fair reward for excellence of service, efficiency of management, and prudent foresight, in providing new facilities against future needs.

If these four principles could be embodied into law, it seems to me that the public would gain immense advantage by the promptest possible return of the properties to their owners. I do not urge for one moment that the old days of unrestricted operation shall be restored. Regulation, with full publicity, has, I believe, come to stay.

But there is no use in blinking our eyes to the stern facts. If the railroads are not permitted to earn sufficient money to attract new capital, and if the risks of the business are not to be met with adequate reward to those who take them, there is no use of again trying the experiment of private ownership. It will be doomed to failure.

The great danger to the public interest in the present immediate situation is that the owners of existing railroad securities (that is, those having most at stake), and the agitators and theorists (that is, those having least at stake), may come to such agreement in opinion that they would jointly become militant in favoring a continuance of the present plan of government control. That would mean that the great interests of the public at large would suffer through lack of appreciation and understanding.

We must frankly recognize that here is a case, not for courts, for commissions, or, indeed, for government. The people will and should decide this issue, and the greatest service railroad men can perform is to see to it that the American people understand clearly the momentous issues involved. If the case is put clearly before the people, I, for one, have perfect confidence that their decision will be the same as that of every railroad executive who is seeking to preserve and promote the welfare and prosperity of our common country.

## The Cost Plus Contract

The next great lesson to which I urgently direct your attention is that bearing upon the relationship between the contractor and the owner. Experience is now the law. No contractor should be called upon nor permitted to undertake the performance of any contract that within the four corners of the paper upon which it appears, is, or may be written, the financial bankruptcy of the contractor. It is unjust, it is inequitable, it is uneconomic. The great lesson of this war on the subject of the relationship between the contractor and the owner is the cost plus contract. This represents the only equitable basis under which a contractor may perform constructive and economic services for the owner. It is the only form of contract which affords protection to both parties. To me all of the energies, the thought, and the experience of this country within its own continental lines during the past year and one-half of this world struggle shall have been in vain unless out of it shall grow, as a permanent institution, solidifying the economic relationship between the contractor and the owner, the cost-plus contract.—Brig. Gen. R. C. Marshall, Chief of Construction Division, U. S. War Department, in address at first annual convention of Associated General Contractors of America.

**$60,000,000 of Rapid Transit Work in New York City May Be Done in 1918.**—The Public Service Commission for the First District has asked the Board of Estimate and Apportionment of New York City to make the necessary authorizations, so that the work of constructing the Dual System of Rapid Transit can go forward unabated and the system now more than two-thirds done and with many of the lines in operation, brought to completion. This course is advocated by the Commission in the belief that the increase in taxable values and in the comfort of the traveling public more than warrant the projected outlay. So far the Board of Estimate has not acted favorably upon the Commission's requisition, and further representations of the importance and need of the work will be advanced by the Commission in the near future. The Commission believes that $60,000,000 of rapid transit work can be done next year. Of this amount $25,000,000 is represented by contracts not yet let. There is yet to be completed about $20,000,000 in $80,000,000 of contracts in force. Besides these two classes of work, the Interborough Rapid Transit Co. and the New York Municipal Railway Corporation will have to spend several million dollars additional for equipment, third rail, etc.

# Precautions to Be Observed in Quarry Blasting with Electricity

The following suggestions on firing blasts by electricity are taken from the December Du Pont Magazine.

Be sure that all the electric blasting caps are in first-class condition and of the same make, before inserting them in the charge. Use waterproof caps in water, and submarine caps in water over 30 ft. deep.

Be sure that each blasting cap is properly inserted into the primer cartridge and that it is securely tied so that it will not be pulled out.

It is best to place the primer in the charge so that the closed end of the cap points toward the center of the charge.

Use care in loading the holes to prevent breaking the wires or scraping off the insulation. Test frequently with the galvanometer in loading large charges.

After the hole is loaded, coil up the protruding wires and cover with dry sacking or paper or dry earth to protect from abrasion and from lighting. Place an empty powder box over the loaded hole if it is to remain for any length of time.

Never load dynamite or exploders into a hole during a lightning and thunder storm. Refrain from loading an easily ignited explosive where sparks are flying from any source. Keep all unnecessary persons away while loading, connecting and firing blast.

Before connecting the holes remove all debris adjacent to them.

In connecting up the holes use care to insure proper connection, make good, tight electrical joints, cut out extra wire, and do not hurry the work but take time to do it properly.

If the ground is damp either raise the joints or tape them well, to prevent short circuits or grounds.

The leading wires used from the source of power to the end holes should be a well insulated copper wire about 14 gauge or equivalent to that. Try to place these so that they will not be injured by the blast and they can be used a great many times.

Test each circuit with the galvonometer to make sure that it has approximately the correct resistance as shown in the table of resistances furnished with this instrument.

Test the source of power with the rheostat, using two exploders connected in series as indicators, to make sure that enough current will be furnished for the blast.

If a blasting machine is to be used be sure that all the exploders are connected in one series and that the number is not beyond its actual working capacity.

In operating the blasting machine do so with full force to insure the development of its capacity current. Always operate the machine two or three times before making the blast to be sure that it is working smoothly and to develop a little residual magnetism in the field coils.

When blasting from a power circuit it is best to have a two-blade switch which can be thrown in for a few seconds and then pulled out. Count to five or ten while the switch is in. Place this switch so that gravity will cause it to stay open. This switch should be in a lock box so that the switch can be locked open with the keys in the possession of the blaster.

When using dry cells they should be in a lock box or in the possession of the blaster who can personally make sure that the wires are not touching the cells.

When a three-post blasting machine is used, be sure to connect one wire to the center post when two wires are used. When three wires are used, connect center post to middle of series and do not make connection directly over a hole.

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**Britain's Railways to Be Nationalized.** In a speech Dec. 4, Winston Spencer Churchill, Minister of Munitions of Great Britain, announced that the Government had decided to nationalize the British railways.

# Logan Waller Page

Logan Waller Page, Director of the Bureau of Public Roads, United States Department of Agriculture, died suddenly of heart disease in Chicago on Dec. 9. Mr. Page was attending a session of the American Association of State Highway Officials. He became ill shortly after dinner and retired to his room, where he expired soon afterward.

Mr. Page was a pioneer in highway work, his first activities being in Massachusetts. He was the inventor of a number of machines used in highway improvement work. He was one of the founders of the Office of Public Roads, and was one of the most active workers in the country for good roads, having much to do with the inauguration of the motor parcel post service.

Mr. Page gave much assistance to members of Congress in the preparation of the federal aid road act, the passage of which in 1916. Since the passage of the act, which provides for federal and state co-operation in highway building, Mr. Page worked with the state highway departments in planning and executing work, and also advised state legislatures in the preparation of measures to enable federal co-operation.

Logan Waller Page

The United States Highways Council, which was formed during the war to co-ordinate the activities of the various federal agencies dealing with road matters, was headed by Mr. Page as chairman. He was a president of the American Highway Association, a director of the American Road Builders' Association, a member, representing the United States government, of the International Road Congress and a member of the American Society of Civil Engineers.

Mr. Page became connected with the Department of Agriculture in 1900, where he served in various capacities until July 1, 1905, when he became Director of the Office of

Public Roads, which, in 1915, became the Office of Public Roads and Rural Engineering, and, in 1918, the Bureau of Public Roads.

Mr. Page was born at Richmond, Va., January 10, 1870. He studied at Virginia Polytechnic Institute and Harvard University and the School of Bridges and Roads of France. He served the State of Massachusetts as a geologist and testing engineer previous to his connection with the federal government. He was the author of a number of publications on road construction and related subjects.

## Considerations in Selecting Compressor for Air Plant*

By LEE A. KNIGHTS.

In selecting an air compressor for a new mine, quarry or contract, the first consideration is naturally to determine what machines or tools and how many are to be operated by the air power.

Practically all handbooks on compressed air, and many manufacturers' catalogs, have for many years contained tables purporting to show the air consumption of a number of different drills of various sizes. It is obvious that a table cannot be prepared that will be correct for all conditions, as for instance; if eight drills were working in two headings of a tunnel it is probable that all of them would be working at the same time and would, therefore, require eight times the amount of air that a single drill would. If, on the other hand, eight drills were scattered around over an excavation to be used for putting in "pop" holes, it is extremely unlikely that over five or six would ever be working at the same time, so a compressor supplying five or six times enough air for one drill would be ample to take care of the entire eight.

A little reflection will show that the only factors that need to be seriously considered in estimating the requirements to take care of a number of drills, are the air consumption of each drill and the greatest number of drills that will be operated at one time. If the air receivers are of exceptionally large capacity they may be counted on to assist materially in carrying the peak load, but under the majority of conditions, the receiver capacity may be disregarded, as receivers are usually only large enough to equalize the fluctuations in pressure due to the pulsation of the compressor, and serve merely as equalizers and not as storage reservoirs.

In comparatively large installations, by which is meant those of twenty or more drills, the compressor capacity may be estimated from the probable average reciprocating time of the drill. For instance, if fifty drills are to be installed and it is expected that each one will be actually running 75 per cent of the time, the air required will be 75 per cent of the amount of air one drill takes, multiplied by 50. This method of estimating should only be used for comparatively large installations. For instance, if two drills are to be installed, which will probably run 75 per cent of the time, it is, of course, necessary to furnish compressor capacity enough for the two instead of one and one-half; since both would be working at the same time. This method of estimating should never be used unless the probable lost time of the drills is equal to at least one drill. That is, 75 per cent of 2 equals 1½; 75 per cent of 3 equals 2¼; 75 per cent of 4 equals 3. Therefore we could expect only three drills out of four to be working on the last mentioned installation and could, therefore, plan on compressor capacity enough for three drills. We cannot, however, assume 2¼ out of 3, as it is evident that either two or three drills will be working and so it would be necessary to have enough air to run the entire three.

**Other Air Uses.**—In addition to the actual requirements of the drills or other main installation of machinery, a liberal allowance should be made for use in other machines such as pumps, motors and forges; and also for leakage. It is folly to attempt to discourage the legitimate use of compressed air, for this is a very economical and efficient method of transmitting power and accomplishing certain results, but great emphasis should be placed on the unnecessary waste of it, especially by leakage.

**Losses from Leakage.**—Very few people fully realize the losses due to leakage of compressed air. A hole 1/16-inch in diameter will cause a loss of about 6 cu. ft. of free air per minute at 100 lb. pressure. A ⅛-in. hole will allow a loss of over 25 cu. ft. per minute, or enough to run a small tool. A ¼-in. hole will allow over 100 cu. ft. per minute to escape, or enough to run a modern rotating hand hammer drill or a stopper. It is seldom that the leakage from a ¼-in. hole would go unnoticed, but a multitude of smaller leaks are frequently allowed, which reduce the total efficiency of the installation to an almost unbelievable extent.

It is only necessary to run the compressor through the noon hour, or at some other time when no machines are working, to see just how many revolutions the compressor has to make to take care of leakage alone, since at that time no effective work is being done. If it requires 50 revolutions of the compressor per minute to keep up the pressure with no machines running, it is evident that if the compressor is normally running at 200 revolutions per minute, only 150 of the revolutions are furnishing air for efficient use, and the other 50 are merely taking care of the leakage. Unfortunately, this test is very likely to leave one with a rather unsatisfactory opinion of the plant; but it serves the useful purpose of impressing one with the necessity of making a liberal allowance for leakage in future installations, and still more important, makes it easy to keep leakage at the minimum, by checking up on this loss from time to time, as machines are added and pipe lines extended.

The same considerations, of course, apply to cutting shed, foundry or shop air power plants.

## Broader Vision for the Engineer

As a class engineers have been extremely modest in their relations with business and public affairs. This has been a natural condition largely due to the education and training which they have received. The education has been along rather narrow and restricted lines of scientific work, leaving out almost entirely the broader studies of literature, common law, economics, business methods and the humanities. After graduation there is usually not much opportunity for broadening out, for it is necessary for a man, if he expects to keep abreast with the development of his profession, to spend nearly all of his surplus energy in reading and studying along the very lines which he followed in school.

Notwithstanding this, it is wise to carry along a course of reading on broadening subjects and to have an interest in affairs which are wholly outside the scientific line of study, and to be identified with engineering and scientific societies in order to get the broadest outlook of life possible. It is for this reason, in order to get a broader aspect of life and acquire a taste for wider reading and study, that it is of advantage for a young man who is to follow some scientific pursuit to take an academic course before he takes his scientific course.

I realize the impracticability for many men to spend so much time at considerable expense in preparation for their life work, but it is almost essential that a man should very early in his career acquire some knowledge of business principles and should endeavor to broaden himself so as to be able to fill with fair satisfaction the position that properly belongs to him in his profession and in the world.

It should be the aim of the engineer to render the best possible service considered in a broad sense. It should be based on facts and not theories or suppositions, and upon scientific laws, which if properly applied will give satisfactory results. Nothing should be taken for granted, and the work or statements of others should be carefully checked before being adopted.

The success of the man will depend upon his ability to produce results in an expeditious manner, which shall be accurate, and in which good judgment has been used, so that the finished product, if it be a physical structure, will be adapted to the use to which it is to be put and shall have been accomplished at a reasonable expenditure. If it be a plan for action it shall be clear and concise and adaptable to the purpose for which it is intended.

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*From December Mine and Quarry.

*Extracts from the Presidential address of Charles T. Main, presented at the annual meeting of the American Society of Mechanical Engineers, Dec. 3 to 6, 1918.

He should be able to understand men and to know them. He should be willing to share his knowledge with his fellow engineers and inasmuch as he will do this through the Society, or other similar means, his interests and outlook will broaden and the return to him will be multiplied. Integrity and perseverance in work and business and fairness and justice to all will in the long run count for more than brilliancy in attainments. Withal he must have a good stock of imagination and judgment, which is sometimes called "horse sense" in the application of fundamental principles to every day problems.

The true success of a man is not measured by the accumulation of money, but by the success of accomplishment of work which adds something to the general good for mankind and for the advancement of the profession.

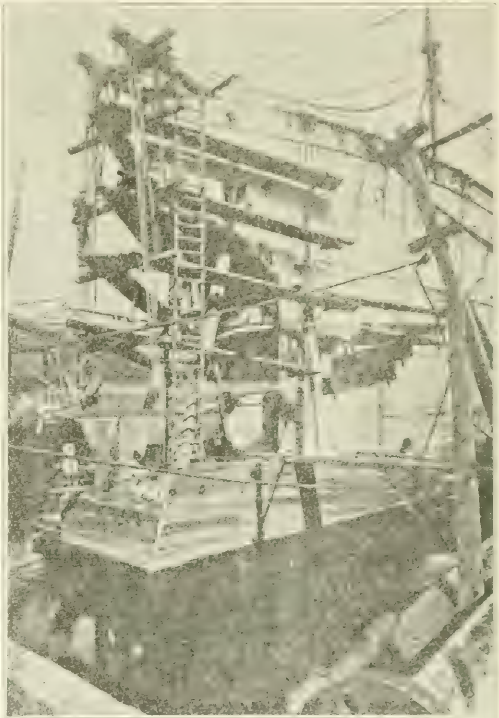
## An Easily Portable Shovel, Strong Enough for Hard Digging

Extreme light weight and traveling ability, combined with real digging ability, are features of the Type "A" ½ cu. yd. Erie shovel, which has just been placed upon the market by the Ball Engine Co., Erie, Pa. The shovel weighs 13 tons. It has two traveling speeds: 1 to 2 miles per hour on low and 2 to 3 miles per hour on high. It is steered by power. The shovel is equipped with a dipper of ½-yd. capacity. The entire machine is designed and built to operate its ½-yd. dipper in hard material, without undue strain on any part. The "A" Erie is rated to excavate 30 to 40 cu. yd. per hour in deep cuts, and 15 to 25 cu. yd. per hour in shallow cuts. These rated capacities have been exceeded over and over again, when conditions have been favorable to larger yardage. The attainable working speed of the "A" Erie is 3 to 6 dippers of material per minute, although the average speed under actual working conditions is usually 1 to 3 dippers per minute. It makes a cut 28 ft. 4 in. wide on floor level, or 46 ft. 4 in. wide at 8 ft. above floor level. The width of cuts and height of dump, as given, are based upon the boom being set at the usual angle of 47½ with the horizontal. The height of dump can be increased beyond 13 ft., as high as 16 ft. 5 in., by raising the boom. The manufacture of "A" Eries has just been placed upon a production basis, but the "A" is not a new machine. The first one that was built has now seen 18 months of very strenuous service. The total repair expense of the shovel in this period is stated to have been only $20.

Type A Erie Shovel Owned by Schreier Bros., Buffalo, N. Y. Excavating a Cellar and Loading Wagons Standing on 11-ft. Bank.

## Cofferdam Built Around Prow of Vessel Enables Making of Repairs at Pier

An ingenious method of repairing a ship is described in a recent issue of the Emergency Fleet News. Some weeks ago a 6,000-ton ship was turned over to the Todd Shipyard Corporation for repairs at one of its dry docks. The vessel was taken over from an Atlantic port, where, in a violent collision with another vessel, its bow had been smashed in as far as 12 ft. back, while the vertical dimension of the injury was about 30 ft.



6,000-Ton Vessel With Cofferdam

With the aid of divers, temporary repairs of timber and cement were made, so that the ship could sail along the coast to reach the port. Upon her arrival at New York, a difficulty arose in obtaining drydocking space. The following method of surmounting the difficulty was employed.

The vessel was placed in drydock, and within about 3½ days a wood cofferdam was constructed at her bow. After this construction was securely sealed, the vessel was taken off the drydock and placed at one of the piers, where the work of repairing the entire bow was carried out. As a result the drydock, which otherwise would have been occupied several weeks possibly on this one job, could be used for the relief of many other vessels.

**November Output of American Shipyards Breaks Record.**—The output of American shipyards during November was 171 vessels of [illegible] gross tons officially numbered by the Bureau of Navigation, Commerce Department, including a small tonnage built for France. This total exceeds that of October by 128 tons and is, of course, the largest on record. Of the November sea-going ships, 60 with a total gross tonnage of 227,293, were steel and 55 of 121,746 gross tons were wood. The non-seagoing ships number 56, with an aggregate gross tonnage of 8,621, which includes one concrete vessel of 11 gross tons.

## Production and Cost of Crushed Trap Rock in 1917

The well-known group of road-building rocks which includes basalt, diabase, and some other dark igneous rocks that are very similar in mineral composition and physical properties furnished 9 per cent of the value of all the stone produced in the United States in 1917, according to statistics compiled under the direction of G. F. Loughlin of the U. S. Geological Survey. The total value of the basalt produced in 1917 was $7,570,885, which is $95,412 or 1.2 per cent less than that in 1916, and the value in 1916 declined 10 per cent ($822,925) from that in 1915. The quantity of this stone produced decreased from 10,233,640 short tons in 1916 to 8,852,640 short tons in 1917, a decrease of 14 per cent. The sales of the 8,067,582 short tons of crushed stone valued at $6,600,957, classified according to use, were divided as follows: Road metal, 3,751,396 short tons, valued at $3,124,088; concrete 3,296,711 short tons, valued at $2,654,410; railroad ballast 1,019,475 short tons, valued at $822,459. There was a decrease of 940,792 short tons (10 per cent) in total quantity, but a small increase, $61,949 (1 per cent), in the total value of crushed basalt and related rocks in 1917. The average price per ton in 1917 was 82 ct., 9 ct. more than in 1916. Road metal showed the largest decrease in quantity, 516,604 tons (12 per cent). The quantity of concrete decreased 341,705 short tons (9 per cent). The value of road metal, however, decreased $68,536 (2 per cent), and that of concrete increased $69,346 (3 per cent). Railroad ballast decreased in quantity 82,483 short tons (7 per cent) and increased in value $61,139 (8 per cent).

## Wage Cases of Railway Technical Engineers May Receive Special Treatment

On Nov. 20, Alfred D. Flinn, secretary of the Engineering Council, called the attention of the Director General of Railroads to the fact that the schedules on "Wages of Railroad Employes" and the supplements thereto contained no mention of the men performing engineering services for the railroads. Mr. Flinn suggested that all technical engineers be given suitable separate classification with rates of compensation in accord with their duties and the expense to which they have been put for their education and their training in preparation for their present duties and responsibilities.. In reply to Mr. Flinn's communication G. H. Sines, chairman, stated:

> This matter was taken up with the Director General and this board has been advised that where such positions as engineers, assistant engineers, draftsmen and other men of technical training or experience employed on the staff of the chief engineer of the Valuation Department or the general staff of the Mechanical Department are not reached by the operation of Supplements Nos. 7 and 8 to General Order No. 27, their cases should receive special treatment at the hands of the Federal Managers.
>
> If any of the employees in the service of railroads under federal control in whom you may be interested feel that the provisions of wage orders affecting their positions are not being properly applied it is suggested that they take their cases up with the Division of Labor in accordance with the provisions of Circular No. 3.

**Drainage Congress Asks Billion Dollar Appropriation.**—The National Drainage Congress which met Dec. 13 and 14 at Chicago, adopted resolutions favoring the appropriation of $1,000,000,000 by the Government for public works of drainage, irrigation and flood protection. Resolutions also were adopted asking the immediate appointment by the President of a waterways commission of seven, three of which should be civilian engineers, and the creation of a national department of public work, with a cabinet officer at its head.

## News Letter

### St. Louis Items.

H. H. Hanankratt has a coal stripping job at Versailles, Mo

E. J. Scott is increasing his forces at his coal mine near Duquoin, Ill.

Since the death of Charles Eby, Seth Eby has taken charge of the outfit. Frank Cox is bossing.

The Chrisman Construction Co., Chrisman, Ill., have several miles of tile laying near Hoopston, Ill., to sublet.

Joe Vorst of St. Genevieve, Mo., has seven teams that he wants to place on a grading job in this neighborhood.

A. Waddell is moving his outfit from Morris, Ill., on to a piece of Missouri, Kansas & Texas R. R. work in southern Kansas.

J. M. White finished his grading job in northern Illinois and moved his team outfit on to some new work in southern Kansas

Columbus S. Jones, the boss stationman, is out on the road looking over his various jobs on the Rock Island and M., K. & T. R. R.

A. L. Cook had quite a time with the "flu" at his home in Ottawa, Kans. We are pleased to announce that he is up and around again.

Contractors when in want of work or labor for their outfits write Koenig's Labor Agency, 612 Walnut St., St. Louis, Mo., or 503 Delaware St., Kansas City, Mo.

The labor market has been easier in St. Louis the past two weeks than at any time in two years. Plenty of labor here now for all jobs. Most of the men heading south.

Mulvill Bros. of Alton, Ill., have sublet four miles of their Wood River drainage job to Smith Bros. and two miles to R. W. Williams of Taylorville, Ill. The balance of the work they are going to do with their own outfit.

The Terminal Railroad Association is constructing three new buildings for the Davis Commissary & Supply Co. in their Madison, Ill., yards. When completed they are going to be the finest and most up to date boarding houses in the country for track and yard laborers. These houses will accommodate two hundred and fifty men.

The St. Clair County Board of Supervisors in its meeting Dec. 7 authorized its Road and Bridge Committee to award contracts for the paving of the roadway between Belleville and Freeburg, Ill. The roadway, seven miles in length, is part of the state-aid road system of St. Clair County, as approved by the State Highway Commission. All grading, widening and bridge construction has long been completed preparatory to permanent paving. The county two years ago voted a $200,000 bond issue to pay its portion toward state-aid roads in the county.

The Boat, Boiler & Tank Co. of St. Louis has been awarded a $700,000 contract by the Inland Navigation Co. for the remodeling of three steel barges for trans-Atlantic service of the French government. Philip A. Rohan, president of the firm, was officially advised on Dec. 13 by telegram from New York. Work will begin about Jan. 1 at Marceau street and the river front on the arrival from New Orleans of the craft. The barges were built for river service and were bought from the navigation company by the French government. They will be completely overhauled and refitted with new machinery. The work is expected to require a year. When completed the craft will be floated to New Orleans ready for their maiden ocean trip.

A. B. KOENIG.

## Personals

**J. Henry Neal,** vice president of the Boston Elevated Ry., has been elected president to succeed Matthew C. Brush.

**C. N. Bainbridge** has been appointed engineer of design of the Chicago, Milwaukee & St. Paul R. R., with headquarters in Chicago, vice H. C. Lothholz, resigned.

**T. J. Wyche,** chief engineer of the Western Pacific R. R., has resigned his connection with the federal administration of the road, but remains with the Western Pacific Corporation, and, it is understood, will act in an advisory capacity for the federal administration.

**A. W. Haddow,** acting city engineer of Edmonton, Canada, has been appointed to take the professorship of civil and municipal engineering at the University of Alberta, succeeding the late Prof. W. Muir Edwards. He will commence his duties on the opening of the institution. Mr. Haddow is a graduate of Queen's University, Kingston, taking the degree of B.Sc. in engineering in 1909.

**Charles D. Emmons,** heretofore second vice president and general manager of the Boston & Worcester Street Ry. Co., has been appointed general manager of the Boston Electric Ry. Mr. Emmons is a civil engineer. For 9 years he was in the engineering department of the Pennsylvania R. R. and entered the electric field in 1901 as superintendent of the Lafayette Street Ry. He also managed successfully other Western roads.

**Frederick Pearson,** who for the past 15 years has been associated with Marshall Field & Co., as advisory engineer, in the development of its various manufacturing and merchandising enterprises in Chicago and elsewhere, has entered the practice of consulting engineer, with offices at Suite 941, Marshall Field Annex Bldg., 25 East Washington St., Chicago. He will continue as advisory engineer to the above firm, in addition to other interests engaging his service. His practice will be restricted to advice and consultation in all branches of electrical, mechanical and chemical engineering.

## Obituaries

**Hale Roberts,** president of the Ellsworth Crushed Stone Co., of Iowa Falls, Ia., died Dec. 5, aged 59.

**John J. Cannon,** chief civil engineer for the Guerber Engineering Co., Bethlehem, Pa., died Dec. 8, aged 71.

**Frank Brumbaugh,** secretary-treasurer and manager of the Elkhart Bridge & Iron Co. of Elkhart, Ind., was killed in automobile collision Dec. 8.

**Minor Q. Woodward,** manager of the Pine Bluff, Ark., Company, owners and operators of the street car line, water works end electric light plant, died Dec. 8, aged 27.

**Charles W. Gindele,** 71 years old, president of the Charles W. Gindele Co., building contractors, Chicago, died recently. Mr. Gindele had been president of the Builders' Club, the Builders' and Traders' Exchange and the Building Construction Employers' Association.

**Albert James Hills,** civil engineer, died at New Westminster, B. C., on Nov. 26, at the age of 82 years. He was born in Sydney, N. S., in 1836, and came to British Columbia in 1880 when the C. P. R. R. was building from Yale. He had a Dominion-wide reputation as a civil engineer in railway building and in geological research.

*Building and Structural Issue*

# ENGINEERING AND CONTRACTING

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field if subscribed for as a weekly at $3.00 a year; but any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year (or any two monthly issues at $1.50 a year) and the 4 special quarterly issues will be sent without extra charge. Three of these special quarterly issues relate entirely to foreign engineering and construction practice, and the fourth is our annual "New Equipment Issue." The *articles* in the first two issues of each month (1st and 2nd Wednesdays) completely cover the municipal engineering and contracting field. The *articles* in the first and last issues of each month (1st and 4th Wednesdays) completely cover county engineering and highway engineering and contracting. The *articles* in the third and last issues of each month (3rd and 4th Wednesdays) completely cover steam and electric railway location, design and construction. See the "mast head" on the first page of the Weekly News Section for information about our weekly contract news.

**Roads and Streets—1st Wednesday**
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies

**Waterworks and Hydraulics—2nd Wednesday**
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power

**Railways and Govt. Works—3rd Wednesday**
(a) Excavation and Dredging (c) Harbors and Docks
(b) Rivers and Canals (d) Railway Construction

**Buildings and Structures—4th Wednesday**
(a) Buildings (c) Ship Construction
(b) Bridges (d) Miscellaneous Structures

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Volume L. CHICAGO, ILL, DECEMBER 25, 1918. Number [illegible]

## E. & C. Index Furnished Only on Request

Heretofore it has been customary to send the index of our articles to every subscriber. In order to conserve paper the index for the six months ending Dec. 31 will be sent only to subscribers who send a postal card or letter requesting a copy of the index. We will then list your name so that you will receive the index twice each year without the necessity of writing us. It will assist us if those desiring the index will notify us at once.

## Who Is a Structural Engineer?

The Illinois Structural Engineers' Association has asked the editor's assistance in framing a definition of Structural Engineer. The first step involves defining engineering.

An editorial entitled "Who Is an Engineer?" appeared in our issue of Dec. 4, and we there gave the following answer: An engineer is one whose vocation is the systematic study of science and the application thereof to problems of economic production.

In this definition the word "production" is to be used in its broadest economic sense. It even includes the effects produced by the military engineer; for while military engineering has for its ultimate object the defeat of an enemy, the attainment of that object is best assured by the application of science in an economic manner.

What is a structure? The following definitions are given in the leading American dictionaries:

Structure: That which is built or constructed; an edifice or building of any kind; in the widest sense, any production or piece of work artificially built up, or composed of parts joined together in some definite manner.—The Century Dictionary.

Structure: A combination of related parts, as a machine, a building, or a bridge.—The Standard Dictionary.

Structure: Something constructed or built, as a building, a [illegible] —Webster's Dictionary.

None of these definitions will meet the approval of structural engineers. A structural engineer does not ordinarily design machinery, yet the Standard Dictionary definition specifically includes a machine, and the other two definitions do not exclude machines from structures.

"A piece of work artificially built up or composed of parts joined together in some definite manner" is a definition that seems to include all engineering structures, but it also includes things that no engineer would characterize as a structure. A lady's hat would fall within this definition.

Before considering both what must be included and excluded from a specification of the word "structure," let us examine three definitions of Structural Engineering, each to be found under the head of Engineering:

Structural engineering [illegible]ern large structures.—Webster's Dictionary.

Structural engineering, the designing and erection of large buildings, great bridges, and the like, especially those of steel.—[illegible]

Structural engineering, the construction of bridges, aqueducts foundations, steel frames for buildings, etc.—Prof. George F. Swain in Encyclopedia Americana.

Prof. Swain's definition is defective in that it merely names a few types of structures and ends with an "etc." that leaves full scope to the imagination—it does not specify. The other two definitions specify "large" structures. But what is large? And why limit structural engineering to large projects? None of the three definitions excludes contractors that are not engineers.

At the outset it should be recognized that every definition of structural engineering must be somewhat arbitrary.

The structural designer is necessarily an adept in the science of strains and stresses as applied to framed works, such as buildings and truss bridges; but his vocation does not limit him to framed structures. He may be called upon to design a concrete arch bridge, or a masonry retaining wall, neither of which is "framed," in the ordinary meaning of the word. Yet in designing either a concrete arch or a retaining wall, the science of strains and stresses must be applied. Indeed, we can not think of any class of structural engineering design that does not involve extensive application of the science of strains and stresses, whereas that science plays a relatively minor part in many other branches of civil engineering. Therefore, it seems desirable to give prominence to the application of the science of elastic deformation of solids as one of the functions of the structural engineer. The word structure must be given a rather arbitrary significance if we are to exclude from structural engineering all kinds of work that fall within other classes of engineering. We must exclude earth dikes and reservoir embankments, sewers and water mains, for such "structures" are usually designed by hydraulic engineers. We must exclude engines, boilers, electric generators, electric transmission lines, and many other "structures," because they are usually designed by mechanical and electrical engineers. In fact, such a great variety of "structures" must be excluded that it becomes a hopeless task to specify in general terms that are not too general just what a structural engineering structure is.

Any attempt to define a structural engineering structure by merely enumerating the types of structures, such as buildings, bridges, etc., is not only unscientific but subject to change as new types come to be regarded as structural engineering structures.

A broad definition may be framed thus:

A structural engineer is an engineer who specializes in the application of the science of strains and stresses and in the economic use of labor and materials incident thereto.

In defense of this definition it can be said that while it does not draw a sharply defined line between structural engineers and other engineers, there is, in fact, no sharp line of demarkation. Also it may be pointed out that no other class of engineers specializes in strains and stresses and the economic problems associated therewith. The hydraulic engineer, for example, should understand the principles of elastic deformation, the strengths of materials, etc., but he certainly need not be as deeply learned in these matters as is the structural engineer; and, conversely, the structural engineer need not be as skilled in the theory and economics in hydraulics as is the hydraulic engineer.

A structural engineer is primarily an engineer, or one who systematically applies science in an economic manner; but his specialty is the design and construction of those types of structures in which a knowledge of strains and stresses and the properties of materials is of paramount importance.

## The Present and Prospective Shortage of Ships

The world's total losses of merchant vessels during the war have been 15,000,000 gross tons, but during the same period 11,000,000 tons have been constructed, leaving a net loss of 4,000,000. At the rate that America and Great Britain are building ships, fully 4,000,000 tons of new ships will be built before the middle of next summer, notwithstanding the fact that our Shipping Board has canceled all contracts for wooden ships that are less than 30 per cent finished.

About 2,400,000 tons of merchant vessels belonging to Germany and Austria had been seized by their enemies before Nov. 11, so that the allied nations are not so short of shipping tonnage as is generally supposed. It has been held that in calculating the present shortage the normal annual increase of tonnage during peace times should be included. But such an inclusion would be erroneous, for it tacitly involves the erroneous assumption that foreign trade has grown at the same rate during the war as it would have grown had there been no war.

Of course there may now come a great expansion of international trade, and at such a rate as to absorb all the new ships that are being built. While this is to be hoped, it is exceedingly doubtful whether it will be realized.

## Bell Telephone Engineers Announce Great Invention the Same Day that Daniels and Burleson Ask Government Ownership

On the twelfth of December, Theodore N. Vail, president of the Bell telephone system, made public the fact that the Bell telephone engineers have perfected a system of multiplex telephony whereby five telephone conversations can take place simultaneously, or 40 telegraph messages may be simultaneously sent over a pair of wires, and the same wires may be used partly for telephony and partly for telegraphy. He truly says that, "It is not too much to characterize this new system as marking an epoch in the development of long distance telephony and telegraphy."

On the same day, Secretary of the Navy Daniels appeared before a congressional committee to urge Government ownership of all wireless telegraph stations, and a bill was also introduced in Congress providing for federal ownership of all telephone and telegraph systems. We wonder how many readers of these events were struck by their incongruity. If some one were to propose that Luther Burbank's nurseries and experimental farms be taken from him and handed over to the U. S. Department of Agriculture, it would be almost on a par with the proposition to deprive the Marconi engineers of their wireless plant and the Bell telephone engineers of their telephone system.

In our issue of Nov. 29, 1916, we published an article entitled, "Inventing an Inventor," in which appeared a photograph of the "composite genius" that made possible the transmission of speech across the American continent. This "composite genius" was a corps of 25 engineers of the American Telephone and Telegraph Co. (the Bell system). In that article it was told how every Government in Europe had failed to solve the problem that these American engineers of a "private company" had solved. We now record an even greater triumph by these same Bell telephone engineers, for multiplex telephony has long been regarded by electrical engineers as the final great step remaining to be taken before really low priced long distance conversation would be practicable. When one considers the great investment in a pair of copper wires extending from New York to San Francisco, and realizes that up to the present only one conversation could take place over such a pair of wires at a time, one needs not wonder that the rate of charge for their use for three minutes has been about $20.

What no Government staff of engineers in Europe has been able to do, these engineers of the Bell telephone company have twice done: First, when they made really long distance telephony possible. Second, when they made it relatively cheap, as they have now done by their invention of multiplex telephony and telegraphy. Yet upon the very day of their public triumph governmental action is proposed by which all telephone and telegraph systems, whether wire or wireless, are to be taken away from their inventors and promoters and handed over to the Government!

Of course it will be said that the Government can hire these engineer inventors; but wouldn't it be well to ascertain how many men of such ability our Government has ever hired? How many noteworthy inventions have been made by men in the employ of this or any other Government? Is our great postal department noted for the inventiveness of its engineers? Indeed, has it any engineer in its employ? We have never heard of them, either individually or collectively, if there are such. Yet the conveying of mail offers countless opportunities for engineering achievement. Even the determination of the unit costs of the different classes of mail service is a problem for rate engineers, but no postmaster has yet recognized this fact, and every postmaster has consequently been deceived by unscientific and grossly false analyses of the costs of the different classes of mail.

Of the inventions of submarines, airplanes, explosives, new types of guns and all the vast variety of war engines, how many are attributable to engineers in the employ of our Government? Next to none, and when a Col. Lewis has come along with a really meritorious device, such as a machine gun, he has had to go to a private company to get it manufactured.

No, the bald fact is that in this great inventive nation, the inventive engineers have rarely been employed by the Government; and when they have been employed it has seldom been for long. This Government is no exception. There is a universal inclination among all governments not only to let well enough alone but to hold out so little reward for the exercise of inventive ability that no government engineering corps has ever yet recorded a single inventive achievement comparable with the invention of multiplex telephony.

Yet there are millions of men so myopic of vision that they favor turning over to our Government all our plants for the electric conveyance of intelligence. If no further progress were likely, it might possibly be wise to hand over these plants to the Government. But the keenest engineers are certain that economic progress in telephony and telegraphy need never cease, and never will cease if these plants are allowed to remain in the hands of private companies. Secretary Daniels' argument that the Government must own the wireless plants is specious, for complete control can be retained by the Government and complete monopoly granted to a wireless company without going to the deadening extreme of Government ownership.

## The Prevention of Influenza

About 20 per cent of the soldiers in American training camps have had the influenza during the epidemic, and of those who had it about 5 per cent died, the total number of deaths being 17,000. During the same period about 350,000 civilians have died; but had the same death rate existed throughout America as in the army camps, more than a million people would have died. If any proof were needed that respiratory diseases are more prevalent where people are congregated, these data furnish the proof.

San Francisco has apparently demonstrated that the universal wearing of gauze masks reduces the number of influenza cases very greatly; for prior to the use of masks there were 2,300 new cases daily, and within six days after the general use of masks the number of new cases daily had dropped to 300.

The preventive vaccine developed by the Mayo Hospital at Rochester, Minn., has been used in 20,000 cases, and has greatly reduced the danger of infection; for by comparison with 60,000 unvaccinated people in the same localities, it has been shown that only one-tenth as many influenza cases per 1,000 people occurred among those who were vaccinated as among those who were not vaccinated.

**Annual Convention of Michigan Engineering Society.**—The Michigan Engineering Society will hold its annual convention at Flint, Mich., Jan. 21-23. Wm. W. Cox, 508 W. Madison street, Lansing, Mich., is the secretary.

## Is a Five-Year Test of Government Operation of Railways Necessary?

William G. McAdoo, Director General of Railways, has recommended Government management of the railways for a period of five years in order to determine whether "unified control" under Government direction is to be preferred to private management without unification. He says:

"The American people have a right to this test. They should not be denied it. It is to their interest that it should be done. In my opinion, it is the only practicable and reasonable method of determining the right solution of this grave economic problem.

"I am not now and have not been for the past year interested in proving or disproving the theory of Government ownership or any other kind of theory. I believe that a five-year test will give the American people the right answer. An ounce of experience is worth a ton of theory.

"There are those who may say that an extension of five years for such a test will mean Government ownership. Personally, I do not believe it. But whether such a test would indicate that the ultimate solution shall be Government ownership or a modified form of private ownership under effective Federal regulation, should not cause us to hesitate or refuse to act."

We concur heartily in the statement that "An ounce of experience is worth a ton of theory," if by "theory" is meant deductive conclusions from premises that are debatable. But we question whether the 5-year test proposed by Mr. McAdoo is sufficient to prove more than is already known. Certainly no 5-year test of this sort will suffice to demonstrate whether Government management is conducive to progress or not.

The proposed 5-year test would unquestionably pile up more evidence in favor of eliminating competition between railway systems, but nearly every student of economics has long believed that such competition should be done away with. We believe that not only railway presidents and directors but political economists and engineers would be almost unanimous in recommending a continuance of "unified control" of American railways, provided an equitable distribution of net earnings could be agreed upon. In short, competent judges of the economic advantage of "unified control" of railways already have sufficient data to be convinced that no further test is necessary.

The really important question is the question of Government ownership, and this is not to be answered correctly by any 5-year test of Government control. It is conceivable that the proposed 5-year test will show favorable costs of operating the railways and that the service to the public will be satisfactory. But what it will not show will be whether private ownership is superior to public ownership in securing constant economic progress in railway construction and operation over a long term of years. It will require a test extending over a period of 15 to 20 years or more to answer this question. Fortunately America need not incur the expense of any such test nor wait such a length of time for an answer. The test has been made for us by several European governments, notably Germany, France and Italy. All that remains for us to do is send to Europe a commission of competent engineers to gather and analyze the data.

It has been frequently stated by many Americans that the Government owned railways of Europe have been very slow to evolve or even to adopt improvements, and that they are fully 30 years behind American railways. If so, this would seem to be a very effective answer to the question of Government ownership of railways. But there are many who doubt the superior efficiency of American railways and there always will be doubters until carefully analyzed data are available.

In our issue of Dec. 18 we pointed out that the problem here involved is primarily a problem in economics, and that engineers are the only economists whose training is such as to [illegible] a correct solution of the problem. Professors of political economy lack practical experience in applying the principles of economics, whereas engineers are constantly engaged not only in the application of all the fundamental principles but in gathering the necessary data. The superiority of this practical experience is well illustrated in the literature on railway and public utility appraisals, operating costs and rate making. Almost all this literature, which is now very voluminous, has been written by engineers. The professors of political economy have done little more than rehash it in their articles relative to public utility and railway rates. So far as we know, not a single new idea as to methods of prorating joint costs, calculating depreciation, determining the economic life of plant units, cost analysis, unit cost keeping, scientific rate schedules, or the like, has come from any professor of political economy. It has all been the work of engineers. Even the science of management, which is the newest branch of economics, was originated by engineers and its development is mainly in their hands.

Mr. McAdoo is sound in asking for data with which to prove or disprove the wisdom of Government ownership, but he evidently does not realize that the data are securable without the 5-year test that he proposes, and he also fails to see that a 5-year test would be wholly inadequate to answer the leading question: Does Government ownership result in as great economic progress as private ownership of public utilities and railways?

## Wooden Ships Repaired with Reinforced Concrete

To the Editor: A good deal has been heard of late, and a good many plans published, of ferro concrete construction as applied to ships and steamers, and it is becoming increasingly evident that this type of craft has come to stay.

We think, however, that we have broken new ground in some work which we have just completed, and which consists of repairs to a wooden ship effected by means of armoured concrete.

Sketches Showing Method of Repairing 200-Ton Wooden Ship with Reinforced Concrete.

The circumstances are briefly these: A wooden ship of some 200 tons displacement, having been purchased by us for the transport of stone and sand in the River Platte estuary, it was found on placing her under the tip wagons that the impact of some 5 tons of stone falling from a height of 15 ft. caused her to leak badly, and on investigation it was found that the wooden ribs of the vessel were entirely rotted away for some 3 ft. on either side of the keel, and the good state of the wooden skin alone kept the bottom from collapsing.

It was judged that the boat in this state could not be docked by means of a slipway, the only means of docking available at the time, as the ribs were not fit to stand the weight.

As the boat was urgently required, it was decided that a good repair might be made by placing new ribs of ferro concrete in the spaces between the wooden ribs, and the repairs were carried out on these lines, at the same time strengthening the false keel by running two continuous concrete girders parallel to it on either side, tied into the ribs.

It will be seen from the drawings that some of the rib bars were taken up over the false keel, so as to tie this to the bottom, and the new concrete ribs were bonded to the wooden ribs by means of short pieces of iron reaching from one rib to another, and seated in holes bored horizontally in the sides of the ribs.

The bond to the skin was effected by means of heavy coach screws which were screwed into the skin planks, the heads being buried in the concrete ribs.

The concrete ribs were taken up sufficiently far to be sure of a good bond with the sound part of the wooden ribs, which were in good condition away from the keel.

The whole of the work was done in a few days, while the ship was afloat in a light condition, and the added weight was very little more than the ballast of old chains, etc., which it was customary to use in this craft, and which was of course dispensed with.

We should be very glad to know if this method of using ferro concrete has been used by any of your readers. We may say that the ship now stands quite successfully the rough treatment at the tips without leakage.

HUME HERMANOS,
Engineer and Contractor.
Buenos Aires, Argentine Republic.

## Tests of Tie Bars of Menai Suspension Bridge

To the Editor: In your issue of Oct. 30, the article entitled "Tests on Tie Bars from the 90 Year Old Menai Suspension Bridge" contains the following statement:

"The fractures occurred always through solid metal, and not at a weld, and revealed a coarsely crystalline structure. The conclusion was reached, therefore, that the trouble was due to fatigue in the metal."

Here we have the old familiar bogy of "Fatigue." The factor of safety for the bars, allowing for full live load, but neglecting windstresses, is given as eight; how, then, could there have been fatigue in the metal unless there was a condition of overstress reaching the elastic limit? It would seem probable that the crystalline structure at points of fracture was caused by the internal stresses, from cooling, set up by the welding method of manufacture for these wrought iron eyebars. In the old days of bridge building in this country, when we used welded bends on wrought iron eyebars, the bars under test often broke near the weld, notwithstanding the fact that the sectional area there was greater than that of the body of the bar. It appeared that the injurious effects of local heating were not always removed by subsequent annealing; and it would appear that this will be the case when the eyebars in the Menai Suspension Bridge are thus treated, unless the bars are raised to high heat and re-working of the metal (to restore the original fibrous structure of the wrought iron) be resorted to. If this re-working of the metal is not done, it will be interesting to see the results of tests upon the annealed eyebars.

F. H. Frankland,
New York City. Consulting Engineer.

## Who Is an Engineer?

To the Editor: Referring to the editorial, "Who Is an Engineer?" in your Dec. 4 issue, I may tell you that I have been lecturing on Engineering Economics for the past 10 years at McGill University and the definition used in connection with my course is: "Engineering is the art of equipping and directing enterprises so as to develop their greatest value." This was, I believe, first developed by my friend R. A. Ross, and recognizes the place of the engineer not only in construction, but also in operation and administration, and from a business and economic standpoint as well as from the scientific and technical. The human element is also included, as direction of and association with men must of necessity be part of the art as defined.

Montreal, Que. FREDERICK B. BROWN.

# The Sub-Contractor

To the Editor: We are sending you a little publication called "Contracting Comments" which we have just begun publishing. We expect to bring out in each issue or edition, in small matters, some matter of major importance in connection with building work. The writer has not made a careful reading or study of each issue of "Engineering & Contracting," but from his reading believes that the virtues of the general contractor have been strongly set forth without due credit to the subcontractor. One article in particular in a recent issue misquoted the fact in our opinion. The so-called sub-contractors throughout the country are beginning to wake up and we think the contracting publications can well afford to give them the recognition which is due them. "Contracting Comment" is purely a local proposition.

JOHN A. WHITAKER & CO.,
Carpentry, Interior Trim, Painting and Decorating.
Detroit, Mich.

[The following is quoted from "Contracting Comments." —Editor.]

Improved Specifications.

A reading of specifications from different architects reveals a great lack of uniform expression and uniform arrangement. The [illegible] architects use different words to express the same idea, and contractors must interpret, more often guess, the meaning in each case as best they can. Such un-uniformity of expression requires special study by the contractor of each individual architect. The average contractor has neither the time nor the genius to correctly interpret all the different meanings, and so it is to be expected that there will be annoyance to all parties concerned. As to arrangement in the specifications of the work under each trade, there are no two architects' specifications which are alike, and it is rare indeed when one comes upon a specification which hasn't bits of the same work mentioned on several pages. The contractor has to keep too much in mind when figuring or getting out the work. The architect, too, has to read much to gather together the scattered data.

How can this be done, you say? Wishing or praying won't do it.

Let the architects work with contractors from each trade and draw up a model specifications for every work and operation, leaving out sizes, grades, etc., unless fitting for all work, to be inserted as required. A few additional words could be added by the individual architect as needed, but a pretty good general wording according to the best practice could be adopted. More details (large scale or full size) would permit less wording in the specifications and, incidentally, make easier figuring and less trouble later on. Then, too, a well made guide for writing specifications would be invaluable to the man who writes the specifications. His work would be done quicker, easier and better. It should not be expected that a perfect standard guide would result, and that the scheme would work like Alladin's lamp, but the matter is certainly worth serious thought.

# Cleaning Iron with the Sand Blast

In a paper presented at the recent convention of the Manitenance of Way Master Painters' Association, M. A. E. Wilson, Master Painter, N. Y., N. H. & H. R. R. R., stated that cost of cleaning bridges by the sand blast will average $1 per ton of metal, which is much cheaper than it can be done by hand. This method will remove all rust, dirt, etc., and leave the iron in a condition that will enable the new paint to stop further corrosion. He stated that the best outfit for railway work is a portable machine that is light and easily transferred in work cars and which can be set up on the job without blocking the main track or stopping trains. In using the sand blast care should be exercised not to hold the nozzle too close or too long on the same place, as it will wear away the metal. The heavy scales of rust must be chipped off with hammers or air chisels, as the sand blast will remove them only by eating through and the men operating the nozzles are liable to go through too far and damage the iron. It is necessary to follow up the cleaning with a coat of good paint immediately, as corrosion starts very quickly after the use of the sand blast. All the surface cleaned should be painted before leaving the work at night, or it will be covered with a fine rust by the following morning.

# Bending Moments in Grillage Beams

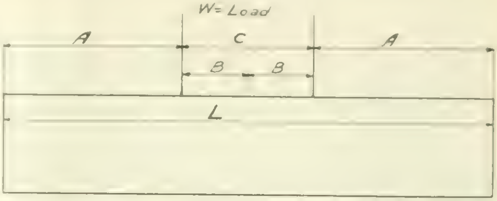
By R. FLEMING

American Bridge Co., New York City.

This article is the outcome of a recent review of calculations for proportioning grillage beams in foundations.

We are indebted to Chicago architects for the high building of steel skeleton construction. In Chicago originated the idea of a spread foundation made of steel and concrete. The Montauk Block, built in 1878, was probably the first building in America to be built on a steel grillage foundation. A grillage of steel rails embedded in concrete was used for part of the cellar in order to obtain space for the boiler.* The spread foundation at once came into wide use. I-beams, with their greater section moduli, soon took the place of rails. At the same time a discussion arose as to the correct method of calculating their strength. This discussion has continued to the present day.

In designing steel grillage foundations the assumptions usually made are: the pressure on the foundation bed is uniform; the pressure of the superimposed load on the beams below is uniform; each tier of beams acts independently of all other tiers; and the concrete filling and covering carry no stress. With these assumptions the problem is: Given a superimposed load distributed uniformly over a certain length on the top of a beam and a uniform upward pressure the whole length on the bottom, what is the safe projection of the beam beyond the superimposed load? Or, the problem may be, what size beam shall be used for a given projection? In either case the solution hinges upon the method of calculating the bending moment.



For determining the bending stresses in grillage beams there are two methods in general use. In Fig. 1

Let W = superimposed load in lb. on the top of a single beam.
= total reaction at the bottom.
C = length in ft. of distribution of the load on top of the beam.
L = length in ft. of beam.
$p$ = W/L = pressure per linear ft. of beam on foundation bed.
M = maximum bending moment in ft. lb.

The first method assumes that the pressure of the superimposed load on top of the beam remains uniform at all times. The maximum bending moment is then at the center and

$$M = \left(\frac{W}{2} \times \frac{L}{4}\right) - \left(\frac{W}{2} \times \frac{C}{4}\right)$$

$$= \frac{W}{8}(L - C) = \frac{pL}{8}(L - C) \qquad (1)$$

This is the equation given in the steel manufacturers' handbooks—Bethlehem, Cambria, Carnegie, Jones & Laughlin, Phoenix and the English handbooks of Skelton & Co. and Dorman, Long & Co., by which bending moment in grillage beams are determined.

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*Foundations of Bridges and Buildings. Jacoby and Davis.

Equation 1 is correct only when the pressure on the upper surface remains uniformly distributed. It is not strictly applicable when the superimposed load is applied through a column base or wall resisting deformation, for the point about which the beam tends to bend is shifted from the center of the base or wall towards the edges.

Some of the advantages in using the first method are: the error is on the side of safety; sections will seldom need to be increased because of insufficient web resistance to buckling; the point of maximum bending moment is not in the plane of maximum vertical shear; no deductions need be made for bolt holes in flanges; and it agrees with the data of the steel manufacturers' handbooks.

The second method takes into consideration only the projecting portion of the beam. The point of maximum bending moment is assumed to be at the edge of the superimposed load, and

$$M = p\left(\frac{L - C}{2}\right) \times \left(\frac{L - C}{4}\right)$$

$$= \frac{1}{8} p\ (L - C)\ (L - C) \qquad \dots\dots\dots\dots (2)$$

Equation 2 is correct only when the edge of the wall, column base or tier of beams through which the superimposed load is transmitted is strong enough to take the uplift from the projection. This is seldom the case. The point of support is shifted by the crushing of the edge toward the center of the base, thus increasing the length of the cantilever portion and the bending moment. It is claimed that the error in assuming the point of maximum bending moment at the edge is more than offset by the error in assuming the beams to act independently of each other and the concrete, the whole foundation being one solid mass and the concrete taking compressive stresses. It is also claimed that there is no record of trouble or failure in any of the many grillages designed by this method, thus justifying its use by practical results.

Waddell in his "Specifications for Piers" (Bridge Engineering, Vol. 1, 1915), has a clause:

"The grillage shall be designed to distribute the load from the shoe over the area equal to the number of beams multiplied by the distance from center to center multiplied by the length. It shall be proportioned for the moment occurring at the edge of the shoe due to the cantilever extension."

Writers of textbooks and reference books are divided in their choice of the two methods. Sometimes they change their opinions. Professor Howe in his "Retaining Walls for Earth," third edition 1903, gives the second method, but in his "Foundations," 1914, presents the first method. The compiler of the Carnegie "Pocket Companion," edition of 1913, presents the first method while in previous editions he, or another compiler, gives the second method.

The relation of results obtained by the two methods may be shown as follows:

In Fig. 1 let A = length of projection and B = one-half length of superimposed load.

Then L = 2A + 2B and C = 2B.

Substituting these values in Equation 1:

$$M = \frac{pA}{2}\left( A + B \right) \dots\dots\dots\dots (3)$$

Substituting in Equation 2:

$$M = \frac{pA}{2}\left( A \right) \dots\dots\dots\dots (4)$$

Thus, if A = B, the bending moment obtained by the first method is twice that by the second; if A = 2B, it is one-half more; if A = 3B, it is one-third more; if A = 4B, it is one-fourth more, and so on indefinitely.

Moran, in his chapter, "Foundations," in the Kidder Pocket Book, 1916, after an exposition of the two methods, suggests the formula—

$$M = \frac{1}{8} p\ (L - C)\quad \left(L - \frac{1C}{2}\right) \dots\dots\dots\dots (5)$$

He adds that until this equation is more generally accepted the engineer or designer will avoid criticism and be perfectly safe in following the first method.

By substituting for L and C their values in terms of A and B, Equation 5 becomes—

$$M = \frac{pA}{2}\left(A + \frac{1}{2}B\right) \dots\dots\dots\dots (6)$$

Godfrey in his "Concrete" says:

"In calculating the bending moment on the beams the point of support of the cantilever should not be taken as the edge of the flange of the beam above or the edge of the column base, but at some point where a good, substantial support is assured."

The Moran formula locates this point at a distance of from 1/2B to 2/3B from the center of the superimposed load.

The question arises, Is there not a more nearly exact method for determining bending stresses in grillage beams than those in common use? It is evident that the deflection of beams must be considered in any method that makes pretensions to theoretical exactness. According to the theory of flexure of beams the solution of the problem resolves itself into a discussion of the combined action of continuous girders with supports upon different levels. An able presentation of the subject may be found in a series of articles, "Stresses in Steel Foundations," by S. B. Durand, published in the Engineering Record, March 11, 18, 25 and April 1, 1899.

But notwithstanding the claims of the author as to saving of material and his design being "dependent upon an interior distribution of loads, which is based upon the conditions governing the action of the external forces and not assumed," his elaborate calculations have not been followed to any appreciable extent. The average designer of grillage beams does not find workable a method which involves their deflection.

The writer follows the first method. As the beams are subject to but little, if any, shock, he does not hesitate to use 20,000 lb. fiber stress where two or more layers of beams are well bedded in concrete. As methods for calculating bending stresses he suggests the following:

For foundations with but one tier of beams, bending stresses be calculated by the first method and 16,000 lb. per square inch fiber stress be used in proportioning.

For foundations with more than one tier of beams, bending stresses be calculated by the first method and 20,000 lb. per square inch fiber stress be used in proportioning. When designed under specifications calling for 16,000 lb. fiber stress the Moran formula be used.

Crushing strength should be investigated, for occasionally a beam strong enough to resist bending has a web too thin to resist buckling. The maximum buckling stress may be considered to occur on a length equal to $C + \frac{d}{2}$, d being the depth of the beam. The required web thickness, t, to resist buckling $= \frac{W}{(12C \times d/2) \times f}$, in which t, 12C and d are in inches and f is the maximum allowable resistance in pounds per square inch of the web to buckling computed from the column formula used in designing the structure. The Carnegie handbook tabulates values of f derived from the formula $19{,}000 - 100\frac{l}{r}$ in which l = d/2 and r = the least radius of gyration of a section equal to the depth of the beam multiplied by its thickness.

The maximum vertical sheer occurs at the edge of the superimposed load and should not exceed an average of 10,000 lb. per square inch on a section equal to the depth of the beam multiplied by its thickness. (Some authorities allow 12,000 lb. when beams are well bedded in concrete.)

# The Poole Harbor, England, Shipyard for Building Reinforced Concrete Vessels

Reinforced concrete vessels are now being built in several English shipyards. The largest establishment is the Lake Shipyard in Poole Harbor. This yard launched its first 1,000-ton reinforced concrete sea going barge last August. The second barge was put in the water on Oct. 5.

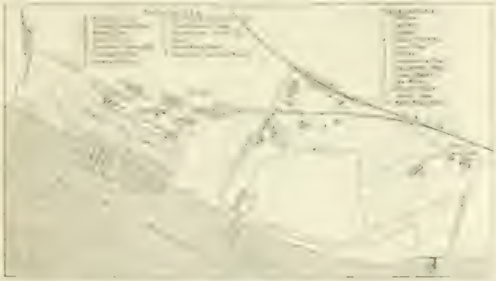

Fig. 1—General Arrangement of Concrete Shipbuilding Yard Poole Harbor, England.

When the yard is in full operation it is expected that a hull will be launched every two weeks. An interesting description of the Lake Shipyard appears in the Nov. 15 issue of The Engineer, to which we are indebted for this matter in our article.

The site has an area of 250 acres and a water frontage of about 1¼ miles. The layout of the yard is shown in Fig. 1. As at present arranged 20 slipways have been provided for. Of this total 16 have been constructed, nine of which were in use in November.

The remaining four—those shown by the dotted lines—are to be built in the near future. The slipways are divided into two sets of ten berths, and it will be observed that the berths of one set are considerably longer than those of the other. It is intended that all the ways shall be housed in so that work can proceed, no matter what the weather conditions may be. There is, in addition to the 20 slipways mentioned, one further slipway for experimental purposes.

The site is comparatively flat, so that no large amount of excavation was required, and yet the requisite slope could be given to the ways without excessive filling. Work on the construction of the yard was commenced in December, 1917, and the first vessel was launched Aug. 24, last.

The general arrangement of the various buildings in the yard will be observed from Fig. 1. The workshops are well equipped, and one of the latest additions to them is an electric welding plant, by means of which the steel reinforcing rods are tacked together to supplant or supplement the binding of them by means of wire. The yard is situated close to one of the lines of the London and South-Western Railway, with which it is in direct connection by means of a series of sidings.

As it was recognized that research work must play an important part in the future of concrete shipbuilding, an experimental laboratory has been established in the yard. All the concrete used in the vessels is subjected to carefull tests, and elaborate precautions are taken to insure the best results.

A drawing showing one of the larger slipways and its housing is given in Fig. 2. This slipway is 204 ft. long and is divided into 17 bays of equal width by means of double lines of concrete piers, 21 in. square, which rest on concrete block foundaticns 2½ ft. square and ½ ft. deep. The piers which serve to support the various working stages are arranged at 12 ft. center in a line parallel to the ways, and 5 ft. 5 in center from one another at right angles to the ways.

The slipway proper is formed of a series of 9 in. concrete dwarf walls, 33 ft. long and 4 ft. high, which are built at 6 ft. centers and arranged at right angles to the center of the berth. Each of these walls rests on a concrete foundation 18 in. wide and 6 in. deep. The length of each bay between the faces of the concrete pier is 36 ft. 10 in. The general design and arrangement of the building and its roof are so well shown in the drawing that a detailed description is not necessary, but we may draw attention to the gantry at the shore end. This gantry stretches the whole width of a series of 10 slipways, and from it two-decked branches extend between the various vessels under construction. Both it and the upper decks of the branch stages running from it between each of the vessels is laid with a 24 in. gage railway. The level of the rails is about the same as that of the highest part of the decks of the vessel when built. From the two stages access is obtained for placing the steel reinforcement, and the upper stage is used for conveying the concrete to the various ships.

Each set of 10 slips has its own plant for crushing and screening the aggregate for the concrete. The concrete after being prepared in mixers, arranged on a staging

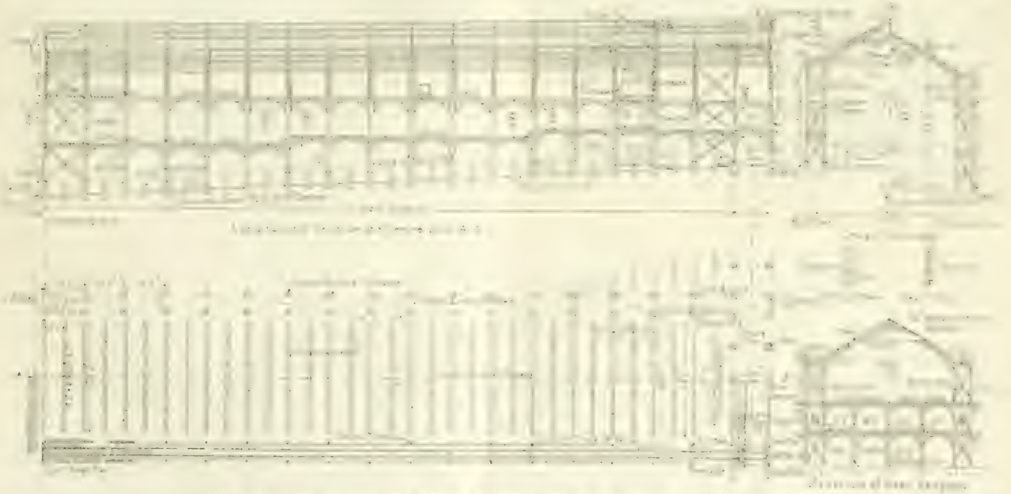

Fig. 2—Details of One of Larger Slipways and Its Housing at Lake Shipyard

raised a little above the gantry, is delivered into specially designed skips running on the rails, there being turntables opposite each branch stage. From the skips the concrete is finally taken to the point in the ship where it is required by means of chutes. The upper decks of the branch stagings, which at the landward side are 18 ft. 10½ in. from the ground, are kept horizontal throughout their lengths, having to be so because the rails are laid on them. The lower decks of the staging are, however, constructed with three levels, which are connected together by means of short flights of steps. At the landward end the difference of level between the upper and lower decks of the staging is 8 ft. 10½ in. In the middle the difference is 11 ft. 4½ in., while at the ends it is 13 ft. 10½ in. The floors of the stages are carried by beams supported by struts, the lower ends of which rest on brackets corbelled from the concrete piers. The inclination given to the launching ways is 1 in 20.

The yard has been laid out primarily for the construction of three types of vessels—1,000-ton sea going cargo barges, 1,000-ton sea going oil tankers and 800 H. P. tugs.

The yard and the slipways were specially designed for the construction of concrete ships by the chief engineer, Mr. E. O. Williams, A.M., Inst. C.E., of the Marine and General Concrete Construction Syndicate, Limited, which is also supplying the designs of the vessels.

## Depreciation of Office Buildings

After much research work in many leading cities the committee on Taxation of the National Association of Building Owners and Managers has reached the conclusion that the minimum annual depreciation of normal office buildings is 3 per cent of actual building cost for each of the first ten years, 2.5 per cent for the second 10 years, 2 per cent for the third 10 years, and thereafter doubtful. These figures are given by Mr. H. J. Burton, chairman of the committee, in a report to the Government Advisory Council of Real Estate Interests. The report also states:

"The best authorities consider that there is a steady and inevitable annual depreciation ranging from 1.5 to 2 per cent for the structural portion of the average modern office building, and from 7 to 10 per cent per annum for the mechanical plant and equipment. This makes the annual depreciation of the combined structure and plant 3.2 per cent per annum.

"The obsolescence of the ornamental and finishing work and of the architectural plan, which reduces the competitive earning capacity of the building, should also be allowed, and should be differentiated from the obsolescence or decadence of the location, which is reflected in the reduced land values."

**Training Course in Naval Architecture at University of Michigan.**—An intensive training course in naval architecture will be started at the University of Michigan and will run 11 weeks. Applicants should be graduates of civil, mechanical, electrical, mining or architectural engineering courses; or, if not graduates, should have had the equivalent of such training. Consideration will be given to men who have completed their junior year in college in any engineering course just mentioned. Applicants should have studied applied mechanics and mathematics, including calculus. The tuition is $32.25 for the course, payable to the University. Each student pays his own expenses. Applications should be made at once to Professor E. M. Bragg, Department of Naval Architecture, University of Michigan, Ann Arbor.

**Erasing Pencil Marks from Tracings.**—Pencil marks can be removed from inked in tracings by means of a piece of felt moistened with gasoline. A convenient method of doing this is to tie a small piece of felt over the end of a medicine dropper filled with gasoline. By squeezing the bulb slightly the felt is kept wet. The felt is passed lightly over the pencil marks and erases them without dimming the ink lines.

# Continuous Reinforced Concrete Beams; What Happens at the Ends?

BY LEONARD C. JORDAN,
Morsmere, N. J.

There is considerable unwarranted variance in the practice of designing reinforced concrete beams when the ends are wholly or partly fixed. This type of construction has been greatly abused by carrying into concrete designing the practice, common and proper in timber and steel construction, of regarding all beams as simple. While it is the case that nearly all steel beams are simple, a strictly simple beam of reinforced concrete is almost as rare as a day in June—and that day the thirty-first of the month.

It is proper to design a beam as a simple one if it will be constructed as a simple beam and if columns and walls can never furnish restraint at the ends. But where columns and beams are cast monolithic and a beam cannot deflect without having tension at the top near supports, then the beam is continuous whether it is so regarded or not. It is only to be hoped that the beam will be continuous in life as well as in the nature of its stresses.

The writer is well aware that many designers take into account the true continuous nature of the beam, yet others, through specifications or employers, are restrained in their methods fully as much as the beams are restrained at supports. It is common practice with many firms to design beams, even when built solidly with rigid supports, merely as simple beams and to throw in at the top over supports 50 per cent as much steel as is figured for the bottom in the center of span. The method of construction renders these beams continuous. And, unless there is partial or complete failure, the top steel must take all tension resulting from negative moment. Since it is true that beams of this type generally withstand the strain to which they are subjected, the questions arise:

(1) Are the stresses in the materials dangerously high?

(2) Can a safer and more economic structure be secured by careful attention to details?

(3) Would an increase in design stresses or a decrease in moment factors be warranted?

(4) What is the proper method of designing continuous beams?

In a partly or wholly restrained beam the positive moment at the center plus the negative moment at one end equals $1/8\ w\ L^2$ for any particular loading, L being the length of effective span and w the load per linear unit. This is for uniform load, to which the present discussion will be limited. For a uniform beam uniformly loaded and thoroughly fixed at both ends the moments are $1/12\ w\ L^2$ at supports and $1/24\ w\ L^2$ at the center. When the central part of the beam is more rigid than the portions near the ends, the points of inflection are located nearer the supports than in the case of a uniform beam section. Even when equal amounts of steel take the tension produced by the two kinds of moment the central portion, due to the flange of the T section, is more rigid than the end portions, which must act as common rectangular beam sections except in so much as they are stiffened by the compression in the bottom steel. The points of inflection are, therefore, farther out toward the supports than in a beam of uniform section. The result is a positive moment somewhat greater than $1/24\ w\ L^2$ and a negative moment correspondingly less than $1/12\ w\ L^2$. When the adjacent spans carry no live load and there is some deflection of columns, depending upon their rigidity, the positive moment is increased slightly further, with an equal reduction in negative moment. These facts possibly justify the action of the Joint Committee in recommending the use of $1/12\ w\ L^2$ for both positive and negative moments. Quite evidently this practice is on the side of safety, although somewhat extravagant provision is made for the positive moment.

The practice of designing a beam for $1/8\ w\ L^2$ at the center and placing over supports one-half as much steel as is used in the bottom in the center of span is unjustitiable. This is equivalent to calculating the negative moment as 1 16 w L, which is too small. The method causes stresses in the negative steel far higher than the computed value. Likewise the actual stress in the center of the span is possibly less than half the calculated amount, the ratio depending upon the positions of the points of inflection. The exact stresses produced are somewhat problematical owing to our limited knowledge of what happens at the ends of continuous reinforced concrete beams. There are some questions which can be answered only by experiment. And the writer suggests certain tests (outlined later) which can add materially to our present information on the subject. For the present the following considerations should lead to more careful attention to details during design.

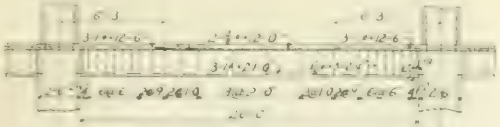

Fig 1

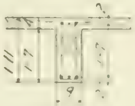

Fig 2

Although we seldom speak of the moment of inertia of reinforced concrete beams, it is proper in the present discussion to think of the relative moments of inertia of the end and center sections. A relatively small amount of top steel at the ends and the presence of the effective flange area throughout the central portion of the span results in a more rigid beam to resist positive moment than to resist the negative. We will denote by R the ratio of moments of inertia of the end and center sections of the beam. R = 1 represents a uniform beam. And smaller values of R represent more flexible end sections resulting from the aforementioned influences. Assuming that the beam ends remain horizontal, we get the following:

| Value of R. | Distance from support to point of inflection. | Positive moment. | Negative moment. |
|---|---|---|---|
| 1 | 0.211 L | $\frac{1}{24}$ w L² | $\frac{1}{12}$ w L² |
| [illegible] | 0.20 L | $\frac{1}{22.2}$ w L² | $\frac{1}{12.[illegible]}$ w L² |
| [illegible] | 0.17 L | $\frac{1}{[illegible]}$ w L² | $\frac{1}{1[illegible]}$ w L² |
| 0.3 | 0.15 L | $\frac{1}{[illegible]}$ w L² | $\frac{1}{[illegible]}$ w L² |

It is seen that with a relatively flimsy end section we approach the condition of equal positive and negative moments. Yet there appears no justification for the practice of figuring the end moment as 1/16 w L². There is also the influence of the deflection of columns. Column deflection and some value of R which, together, would locate the points of inflection at 0.15 L from the supports, for instance, would produce the bending moments shown in the last line of the table. Increased deflection of the columns would further decrease the negative moment. Still this consideration does not warrant the use of a very small amount of steel over supports. For be it remembered that the column deflection comes about merely by the tension in this same top steel.

The last column of the table gives an affirmative answer to question (1). Apparently 1/12 w L is the maximum probable value of the negative moment. This moment is attained in a uniform beam and is closely approached in beams whose sections vary considerably in rigidity. The Joint Committee recommends this value. Provision for a smaller moment should be regarded as dangerous practice.

Question (2) can be answered further by considering the values in the positive moment column of the table. It appears that a positive moment as great as 1/16 w L would be difficult of attainment, particularly so when ample provision is made for the negative moment. It would seem, therefore, that a safe design would result from the use of this moment. However, before using this value, the writer would await an agreement to this moment factor by many men capable of rendering reliable opinion in the matter. The Joint Committee recommends 1/12 w L² for the positive moment. Yet it might be that the members permitted themselves to be somewhat influenced by the prestige of established bad practice, which always is a difficult obstacle to overcome. Possibly the Committee will see fit to make further modifications of its original report, in which case the continuous beam is hereby recommended for further consideration.

In regard to question (3) the writer wishes to protest against the use of stresses any higher than those recommended by the Joint Committee. However, as already stated, he feels certain that there should be a change in the calculation of positive moment. It is his firm belief that in many modern structures there are beams in which the positive steel is never stressed to more than 10,000 lb. per square inch, while the negative steel is working at fully twice this amount in tension and with bond stress at or near the point of partial failure, although the calculated stresses were within the usual specified limits. The specified stress should not be increased, but care should be exercised to gain close agreement between calculated and actual stresses. Structures should be so designed that the available strength of the materials is used to economic advantage.

In answer to question (4) the writer submits an example of beam design which he regards as being within the spirit of the Joint Committee's conservative recommendations, although there are some features which the Committee failed to mention and in regard to which the writer wishes to invite an expression of dependable opinion. These points are the manner of taking into account the stress in the bottom steel at the end of span, the disposition of this stress beyond the end of clear span, the allowable bond stress and end resistance when the force acting on a rod tends to push it into a large mass of concrete, and the means of taking care of the specified shearing stress. Figures 1 and 2 show a beam built solidly into fairly large columns, the clear span being 20 ft. All main steel is

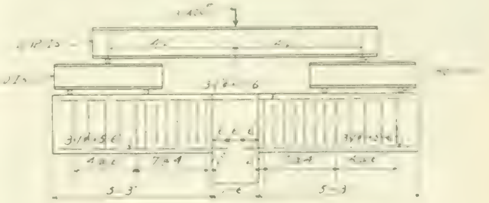

Fig 3

Fig 4

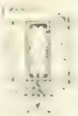

Fig 5

Fig 6

straight. This is a good practice which is followed by many firms and which is economical of steel and labor when all the stresses in the rods are taken into account. With a total load of 1,750 lb. per linear foot the end shear is 17,500 lb. and the positive and negative bending moments are figured to be 700,000 inch pounds, using the 1/12 $w L^2$ rule. The value of jd at the center of span is 19.4 in. and the stress in the bottom steel is computed to be 15,300 lb. per square inch. If specifications permitted the use of 1/16 $w L^2$ as the maximum positive moment we would use three 7/8 in. round rods. jd would be 19.5 in. and the computed value of the tensile stress would be only 15,000 lb. per square inch. If this amount of steel is too little, a convincing demonstration of its inadequacy would be interesting. However, as previously stated, the writer prefers to adhere to the more conservative practice of using the 1/12 rule until there is good agreement concerning the advisability of adopting the smaller computation of positive moment. Besides, there are more important questions regarding the conditions at the ends of beams.

In the beam of Figs. 1 and 2 the section resisting negative moment is $d = 21$ in., $b = 9$ in., $A_s = A'_s = 2.36$ sq. in. If we ignore the compression in the bottom steel, the stresses appear to be $f_s = 16,600$, $f_c = 9.20$, jd being 17.82 in. However, unless the bottom rods have buckled or slipped longitudinally through the concrete, the compression in them is 15 times the stress in the adjacent concrete. There is no intermediate ground. Either this failure has occurred or it has not. If there has been this partial failure, the bottom rods are a source of weakness at the ends of span and they should be cut off in the region of the point of inflection where there would be no injurious effect from a sudden transfer of compression from steel to concrete. On the other hand, and this is in all probability the true condition, if all the beam materials are intact, the only reliable means of procedure is that guided by recognition of all stresses which we know to be in existence.

Taking this compression into account, the end portion of the beam must be regarded merely as a double reinforced rectangular beam. In the given example, $p = p' = 0.0125$. Exact formulas for investigating this section give $kd = 7.82$ in., $jd = 18.62$ in., $f_s = 16,000$, $f_c = 628$, and $f'_c = 7,000$. The compressive stresses are well within the limits specified by the Joint Committee and should be regarded as safe. The shear on the bjd section of the concrete is 105 pounds per square inch.

The next point to investigate is the bond stress. For the present designate by $M_n$ the negative moment at the face of column, by $M_u$ the negative moment at U, a small distance y from the column, and by V the end shear, the units being in pounds and inches. $M_n = M_u + Vy - \frac{1}{2} w y^2$, of which the last term is negligible. The total stress in the top steel at the column face is $\frac{M_n}{jd}$. And the total stress in this steel at U is $\frac{M_u}{jd}$. The change of stress in the distance y is $\frac{M_n - M_u}{jd} = \frac{Vy}{jd}$. At the extreme end the change of stress in the top steel is at the rate of $\frac{V}{jd}$ per linear inch of rod. This is the total bond stress per linear inch of rods. The unit bond stress is, therefore,

$$\frac{V}{jd\Sigma o} = \frac{17,500}{18.62 \times 3 \times 3.14} = 100 \text{ lb. per square inch.}$$

This is the formula generally used. But it applies only to the tensile steel. In the case of the compressive steel there is no relation between $\Sigma o$ and bond stress. All compressive and tensile stresses are proportional to the bending moment. And the change in these stresses is proportional to the change in bending moment. $f'_s$ at the end of beam was computed to be 7,000. It follows that the change in $f'_s$ in one inch of length is $\frac{17,500}{700,000} \times 7,000 = 175$ lb. per square inch, which amounts to 138 lb. in a 1 in. rod. This change of stress in a rod divided by the circumference of the rod gives the value of the bond stress, which is 44 lb. per square inch of surface. In general, the steel stress is proportional to the distance of the steel from the neutral axis. It follows that, with equal number and size of top and bottom rods, the bond stress is proportional to the distance from the rods to the neutral axis. Commonly the tensile steel is more than twice as far from the neutral axis as is the compressive steel, which shows that the bond on the bottom steel is never critical and also that larger rods may be employed in the bottom of beam than in the top. In many cases this arrangement would be very convenient owing to the desirability of a narrow beam stem and the possibility of permitting the top rods to occupy somewhat greater width of space. Beyond the point of inflection, wherever it may be, the bottom rods are in tension, but the shear there is less than at the ends and the bond stress is unlikely to approach a critical value. Special investigation of the shear in the bottom rods will be unnecessary unless these rods are considerably larger than are the negative rods.

The subject of bond stress suggests mention of similar inquiry into the conditions in simple beams. In such members the maximum bond stress is the end shear divided by the product of jd and the sum of perimeters of rods. This is true, however, only when the concrete has been subjected to tensile stresses sufficient to produce initial cracking. At the ends, where the moment is very small and where the concrete is still intact, it will be seen that the bond stress is somewhat different, in this case being less than if the initial cracking had taken place. The usual method of computing this bond, based upon the assumed cracked section, is the only advisable course to follow. For in simple beams an initial bond failure would lead to a progressive rupture that could result only in the ultimate failure of the beam as a whole. Hooking the ends of rods or extending them some distance into supports will reduce this danger.

We now come to the result of initial bond failure in the top steel of continuous beams. Very probably there frequently is such failure in beams which have an inadequate amount of negative steel. This matter is not so important as it might seem at first glance. The maximum bond stress in the top steel is at the end of span, near the central point of rod. An initial bond failure here would merely mean a readjustment of stresses and a slight slipping of a part of the rod through the adjacent concrete. The end of the rod is well anchored in the concrete of the portion of beam having far smaller shear. Indeed, it is difficult to imagine a complete failure due even to having the top rods run through smooth holes in the concrete for some distance near the support so long as they are well bonded throughout the rest of their length. In this connection we might ask whether conservative practice should not permit higher bond stress in such steel than is considered safe in rods whose initial bond rupture would mean final failure. Also, would it not be reasonable to consider the question of permitting higher shear in concrete at the ends of continuous beams where the concrete is under large compressive stress and where a crack entirely through the compressive area would be pressed together so securely that slipping would be difficult?

The bottom steel is under considerable compression at

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Formulas for double reinforced beams, as given in the principal text books are incorrect, as they regard both compressive steel and concrete as occupying the same space. The resulting error in stress computation will amount to 2 or 3 per cent, which is not important except when exact figures are desired as in the investigation of test members. The correct formula for k is

$$k^2 + 2\left\{np + (n-1)p'\right\}k = 2\left[np + (n-1)p'\frac{d'}{d}\right]$$

The further computations of finding jd and the several stresses can be accomplished most easily by expressing $f_s$ and $f'_s$ in terms of $f_c$, taking the moments of the compressive stresses about the tensile steel as a center, and equating the resisting moment to the bending moment.

the end of span, as has been shown. And we must consider what becomes of this stress, i. e., how it is transferred to the concrete within the body of the column. Unless the rods extend a few inches into the column, rather high transfer stresses are sure to exist. In the stated example the bottom rods extend 6 in. beyond the end of clear span, $f'_s = 7,000$ and each rod carries a stress of 5,500 lb. In some manner this 5,500 lb. is transferred to the concrete. If 1,570 lb. is taken by the concrete directly beyond the end of rod (2,000 lb. per square inch), there is left 3,930 lb. to be taken by bond on the 6 in. length or 208 lbs. per square inch of surface. High compressive and bond stresses are not especially dangerous at this point, for there is little opportunity for the materials to become disrupted, owing to the bulk of the column, and there is no space into which the rods can push.

Figure 6 illustrates a simple test that would show very readily just what strength a rod would have in resisting a force that tended to push it into a block of concrete. And Figs. 3, 4 and 5, illustrate a test piece by means of which the stresses existing in the ends of a continuous beam may be investigated very easily. The beam section is the same as the ends of the beam illustrated in Figs. 1 and 2, except that the stirrups have been spaced closer together to avoid possible early failure by shear. The loading illustrated in Fig. 3 will give the same moment and shear as are used in the example, moment of 700,000 and shear of 17,500.

At this season of the year when engineering students are working on their theses the writer wishes to suggest that experiments be made along the lines of the tests illustrated by Figs. 3 and 6. By varying the diameter of rod and the length embedded in concrete in the specimen of Fig. 6, some interesting data would probably be disclosed. Engineering students, through such tests, have an opportunity to make a real contribution to the available stock of information on this very important subject. This matter offers one of the best fields possible for investigation suitable to the needs of thesis work. And investigation by students, under the guidance of their professors, is possibly the best means of securing the desired thorough understanding of the subject. Supposing that students will give this matter some attention, the writer would be glad to correspond with those who make experiments of the kind suggested in order to put students in touch with each other, if they express a desire to that effect, so that each may have the advantage of all experiments made and that all data may be gathered together for the advantage of the engineering profession.

The writer trusts that investigation and discussion of the stresses of continuous beams will result in better understanding of the subject and in the design of structures that will be safe in all respects and yet which will make economic use of the materials of which there is so great scarcity at present.

## England to Spend $600,000,000 on Housing Project

In an address delivered Nov. 25 at the 7th National Conference on Housing, Thomas Adams, Town Planning Adviser of the Canadian Commission of Conservation, stated that England proposes to spend at least $600,000,000 on new houses in 3 years after the war. The state will meet 75 per cent of the loss due to expected falling in value of materials and labor during the next seven years. This will mean a national contribution of about $188,000,000 and a local contribution of about $47,000,000. England will simultaneously insist on the standards of private construction being raised; and will go on demolishing its slums. No less than 60,000 houses were made fit by landlords in 1913 under Government compulsion. The density of house building in England will be governed by town planning schemes, fixing 12 houses to the acre in towns and 8 to the acre in cities. Land purchase, local transit, and house building will proceed side by side.

## Compressive Strength and Modulus of Elasticity of Gunite

During the past year the U. S. Shipping Board, in cooperation with the Bureau of Standards, has made extensive tests to determine the compressive strength and the modulus of rupture of gunite. Tests also were made this year by Prof. McKibben of Lehigh University to determine the modulus of rupture and other characteristics. These tests are summarized in a paper: "The Cement Gun, It's Application and Uses," presented Dec. 23 before the Society of Municipal Engineers of the city of New York, by B. C. Collier, general manager of the Cement Gun Co., Inc. The matter following is taken from Mr. Collier's paper:

**Results of Modulus of Rupture Tests by Prof. McKibben.** —Tests have recently been made by Prof. McKibben of Lehigh University to determine the modulus of rupture of gunite, and his report shows results on slabs shot as follows:

A. Shot horizontally at one operation, 2 in. thick.
B. Shot horizontally at one operation, 4 in. thick.
C. Shot horizontally, four layers, 1 in. each, 1-hour intervals.
D. Shot horizontally, four layers, 1 in. each, 4-hour intervals.
E. Shot horizontally, four layers, 1 in. each, 24-hour intervals.
F. Shot vertically at one operation, 4 in. thick.
G. Shot vertically, four layers, 1 in. each, 1-hour intervals.
H. Shot vertically, four layers, 1 in. each, 4-hour intervals.
J. Shot vertically, four layers, 1 in. each, 24-hour intervals.
K. Shot vertically at one operation, 4 in. thick.
L. Shot vertically, four layers, 1 in. each, 4-hour intervals.

It was the original intention in making these tests to get the modulus of rupture on samples A, B, C, D and E and, therefore, provision was made to eliminate the possibility of weak material along the corners of the forms. It was further intended to use the slabs that were shot against vertical forms to make compression tests. It was found, however, that the gunite was so hard that the ordinary cutting machines would not suffice to cut it into cubes, and so it was decided to use these slabs for additional rupture tests. It will be noted from the following tests that these slabs did not show as good results as did the horizontally shot samples, and as all other evidence warrants the belief that vertically-shot gunite is slightly stronger than that shot horizontally, the assumption has been drawn that the "weak" corners which were included in the area were responsible.

MODULUS OF RUPTURE

| | 28 Days— | 60 Days |
|---|---|---|
| A | 615 average of 3 samples | [illegible] average of [illegible] samples |
| B | 445 average of 2 samples | 802 average of 2 samples |
| C | 381 average of [illegible] samples | 766 average of 4 samples |
| D | 355 average of 3 samples | 621 average of [illegible] samples |
| E | 210 average of 3 samples | [illegible] average of [illegible] samples |
| F | | 581 |
| G | | 494 |
| H | | 550 |
| J | | [illegible] |
| K | | [illegible] |
| L | | [illegible] |

These results were obtained by placing a knife-edge load on the center of each slab which was supported on knife-edge supports, and the notation is made, "Every slab failed by breaking practically straight across the center of the span."

All of these slabs were shot from bank sand having an average moisture content of 5.26 per cent. The mechanical analysis showed 73 per cent passing a No. 10 sieve, 25 per cent passing a No. 40 sieve, and 2.3 per cent passing a No. 100 sieve. The cement used was a standard brand of "Valley" cement. Tensile tests made on hand-made briquettes of this cement and sand mixed 1 to 3, gave an average tensile strength of 142 lb. per square inch. Other interesting data gathered from these tests show:

1. That to 625 cubic ft. of dry mixed sand and cement fed to the gun was added 71 cubic ft. of water.
2. The percentage of dry material to completed gunite averaged about 50 per cent.
3. The percentage of sand rebound was about 15 to 20 per cent.
4. The voids in the sand averaged 40.7.

Tests were made on the total absorption of gunite 28 days old; samples taken from slab B showed 4.2 per cent; slab C, 3.7 per cent, and slab D, 5.5 per cent.

**Compression Strength and Modulus of Elasticity Tests**

**of U. S. Shipping Board.**—At about the same time that the tests were being made by Prof. McKibben, the United States Shipping Board, in cooperation with the Bureau of Standards, began a very exhaustive set of tests to show the compressive strength and modulus of elasticity of gunite. The engineers of the board experienced the same difficulty as did Prof. McKibben in cutting the samples into testing prisms, but as the facilities offered by the Bureau were so extensive they were able to complete an extensive program of tests, although they were able to get 28-day tests on only a few samples. These few tests showed that there was a very much smaller proportion of increase between the 28-day tests and the 90-day tests than is usually the case with concrete. The figures herein quoted will apply to tests made on samples 90 days old or slightly older.

There were a total of 384 prisms tested and an analysis of the results produces some very interesting and instructive data. Two hundred and four of these prisms were shot against both vertical and horizontal surfaces with different proportions of mortar, and under other varying conditions. All samples were tested with the breaking load applied both perpendicularly to the plane of the applied layers, and also parallel with these planes. This was done in order to determine whether the samples shot in varying thicknesses of layers, and at varying intervals showed any difference in strength resulting from possible weakness of bond.

The average ultimate compressive strength of all of these 204 prisms was:

Tested perpendicularly....... 4,470 lb. per sq. in.
Tested parallel............... 4,258 lb. per sq. in.

The other 180 prisms were shot through heavy screens of reinforcing, the object being to determine the strength of gunite behind the reinforcing bars. These samples, shot against both horizontal and vertical surfaces, showed a strength of:

Tested perpendicularly....... 4,341 lb. per sq. in.
Tested parallel............... 4,531 lb. per sq. in.

Of the 180 prisms, 21 of these were shot against horizontal surfaces and showed:

Tested perpendicularly....... 4,724 lb. per sq. in.
Tested parallel............... 4,521 lb. per sq. in.

159 were shot against vertical surfaces with results:

Tested perpendicularly....... 4,291 lb. per sq. in.
Tested parallel............... 4,532 lb. per sq. in.

Of the 204 prisms above referred to, 168 were shot against vertical surfaces, and the average of the samples showed:

Tested perpendicularly....... 4,500 lb. per sq. in.
Tested parallel............... 4,283 lb. per sq. in.

The other 36 prisms were shot against horizontal surfaces with the result of an average:

Tested perpendicularly....... 4,345 lb. per sq. in.
Tested parallel............... 4,142 lb. per sq. in.

In this case it is noted that the samples tested perpendicularly showed more strength, which is what is to be expected, when it is recalled that the layer or film of dust that settled on a horizontal surface precluded a perfect adhesion between the various layers, but even this difference is so slight as not to be reckoned with.

A further analysis will show results that are of still greater interest and benefit in determining what can be done with the material in actual practice. Although it is not considered good practice ordinarily to place as heavy a layer as 6 in. of gunite at one operation, due to the tendency of gravity to break it down, still this was done in these tests, and the results of 18 prisms shot against a vertical surface showed:

Tested perpendicularly....... 4,631 lb. per sq. in.
Tested parallel............... 4,490 lb. per sq. in.

Forty-eight prisms were shot aganist vertical surfaces in three layers of 2 in. each at varying intervals, and the results were:

Tested perpendicularly....... 4,454 lb. per sq. in.
Tested parallel............... 4,073 lb. per sq. in.

One hundred and two prisms were shot against vertical surfaces in six layers of 1 in. each, at varying intervals, and the test showed:

Tested perpendicularly....... 4,492 lb. per sq. in.
Tested parallel............... 4,336 lb. per sq. in.

It will be of interest to compare the two last referred to results. The results of the six layers showed that the strength of the sections were practically identical each way, while the results from the three layers showed a difference in favor of the samples tested perpendicularly. Of the samples tested, however, about half showed a greater strength under parallel testing, which offsets any pre-disposition to suppose that these results are an evidence of weakness.

Of the samples shot against horizontal surfaces 15 were shot in a single operation, or 6 in. thick. They resulted:

Tested perpendicularly....... 4,470 lb. per sq. in.
Tested parallel............... 3,928 lb. per sq. in.

Eighteen prisms were shot in three layers of 2 in. each, and showed:

Tested perpendicularly....... 4,090 lb. per sq. in.
Tested parallel............... 4,123 lb. per sq. in.

Only three prisms were shot in six layers of 1 in. each, with results:

Tested perpendicularly....... 5,250 lb. per sq. in.
Tested parallel............... 5,320 lb. per sq. in.

In making a further analysis, it is interesting to develop the fact that the difference in intervals between layers of gunite when properly applied, against surfaces that have been thoroughly wetted, produces very little variation in strength.

Six of the vertical prisms were shot with 1 to 3 mixture in three layers with 72 hours intervening. They showed a strength:

Tested perpendicularly....... 3,755 lb. per sq. in.
Tested parallel............... 3,485 lb. per sq. in.

Inasmuch as most of the samples discussed above were shot at 24-hour intervals, the comparison is apparent.

It developed in this work that rich mixtures under normal treatment developed shrinkage cracks.

Forty-five prisms shot vertically with a mixture of one part cement and two parts sand (or aggregate) resulted:

Tested perpendicularly....... 4,819 lb. per sq. in.
Tested parallel............... 4,652 lb. per sq. in.

while with a mixture of 1 to 2½ six samples showed:

Tested perpendicularly....... 4,783 lb. per sq. in.
Tested parallel............... 4,500 lb. per sq. in.

On the other hand the 1 to 3 mortar showed in 105 prisms a test of:

Tested perpendicularly....... 4,266 lb. per sq. in.
Tested parallel............... 4,006 lb. per sq. in.

It would, therefore, seem that the most advantageous mixtures are 1 to 2½ for work demanding high water resisting qualities and 1 to 3 for ordinary conditions.

Some samples were developed with the use of aggregate ranging up to ½ in., on the assumption that the larger material would show greater strength, as is the case with concrete. As the work progressed, the results showed that here was no advantage and that a well-graded mixture, ¼ in. and under, best satisfied all conditions. As a matter of fact, some excellent results were obtained by using Potomac River sand directly, without any attempt at graduation. This sand was of about the same character as that analyzed above in the report of the Lehigh University, and is what is termed "a good concrete sand."

A study of these results will show that a safe assumption for 1 to 2½ gunite will be 4,500 lb. per square inch ultimate compressive strength, and for 1 to 3 gunite 4,000 lb. per square inch.

In developing the modulus of elasticity, it was not possible to test as many samples as for compression, but the results obtained were highly instructive and beneficial:

Three prisms were made of 1 to 2 gunite and showed an average modulus at 90 days of 5,417,000 lb.

Two of 1 to 2½ gunite were tested at 90 days and showed an average of 4,670,000 lb.

Eight tests were made on prisms of 1 to 3 gunite with an average result of 4,705,000 lb.

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**Only 27 Per Cent of Capacity of Fabricating Shops Contracted for in November.**—Structural activity in November, as indicated by the records of the fabricating shops, was at the lowest point in four years. The records of the Bridge Builders' and Structural Society, as collected by its secretary, show that during the month 27 per cent of the entire capacity of the bridge and structural shops of the country was contracted for.

# Formulas for Design of Wedge-Shape Reinforced Concrete Footings

By R. P. DAVIS,
[illegible] Engineer, West Virginia State Road Commission.

In the design of wedge-shape reinforced-concrete footings the usual formulas for reinforced concrete must be somewhat modified. If $f_c$ represents the maximum allowable compression on the concrete, the permissible maximum stress on a vertical plane must be $f_c \cos^2\alpha$, where $\alpha$ is the angle which the upper surface of the concrete makes with the horizontal. This is for the reason that the true maximum stress occurs on a plane perpendicular to the upper surface and not on a vertical plane. This principle is well understood in the design of dams, but is not brought out in most texts on concrete design.

The relation between the maximum stress and the stress on a vertical plane can be demonstrated as follows: Taking a differential mass of thickness unity (Fig. 1) as a free body and denoting the intensity of normal stress on the vertical plane by $f'_c$, since the sum of the horizontal forces on the free body must equal zero, it is evident that the total shear on the plane AB must be $f'_c\, dy$, and its intensity, $f'_c \frac{dy}{dx}$. As the unit shear, at any point, on two planes at right angles to each other must be equal, it follows that the intensity of shear on BC is also $f'_c \frac{dy}{dx}$ and the total shear is $f'_c \frac{dy^2}{dx}$. The resultant stress on the plane BC equals the square root of the sum of the squares of the shear and normal stresses or $f'_c\, dy \sec\alpha$. Now, taking the part BCD as a free body, to maintain equilibrium it is evident that the total stress on the plane BD must be the same as that on BC and as its length is $dy \cos\alpha$, the intensity of stress on it will be $f'_c \sec^2\alpha$. It can easily be shown that this stress is normal to the plane. Calling this intensity $f_c$ it follows that $f'_c$ equals $f_c \cos^2\alpha$. It is to be noted that the shearing intensity on a vertical plane equals the normal intensity multiplied by the $\tan\alpha$.

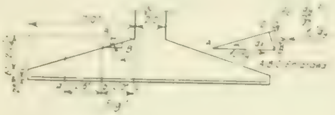
Fig. 1

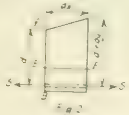
Fig. 2

With this reduced value of $f_c$ the depth to the steel and the amount of reinforcement may be determined by the usual formulas.

Using the standard nomenclature for reinforced concrete and making the usual assumption that the steel takes all the tension, the proper formulas for diagonal tension and bond in wedge-shape footings are, respectively—

$$v = \frac{V}{bjd} - \frac{M \tan\alpha}{bjd} \text{ and } u = \frac{V}{\Sigma o\, jd} - \frac{M \tan\alpha}{\Sigma o\, jd}$$

instead of the more commonly used formulas,

$$v = \frac{V}{bjd} \text{ and } u = \frac{V}{\Sigma o\, jd}.$$

Taking an element of the beam dx long and thickness b, perpendicular to the plane (Fig. 2), the total stress, S, in the steel on the plane AB is $S = \frac{M}{jd}$, where M is the bending moment in the section, and likewise $S' = \frac{M'}{j(d+dy)}$. At any point the intensity of diagonal tension equals the intensity of horizontal shear and an expression for the latter may be obtained by taking the part below any plane EF as a free body—this plane being below the neutral axis. Placing $\Sigma X$ equal to zero.

$$vb\, dx = \frac{M'}{j(d+dy)} - \frac{M}{jd}$$

$$vb\, dx = \frac{M' - M}{j(d+dy)} - \frac{M\, dy}{d(d+dy)}$$

$$v = \frac{dM}{b\, dx\, j(d+dy)} - \frac{M dy}{bjd(d+dy)dx}$$

But $dM/dx = V$ and $dy/dx = \tan\alpha$; dy may be dropped from the denominator since it is a differential quantity while all others are finite. Hence, $v = \frac{V}{bjd} - \frac{M \tan\alpha}{bjd}$

Since all the shear goes into the steel in the form of bond, if u is the unit bond stress,

$$u\, dx \Sigma o = v\, dx\, b$$

$$u = \frac{vb}{\Sigma o} = \frac{V}{\Sigma o\, jd} - \frac{M \tan\alpha}{\Sigma o\, jd}$$

The following problem taken from "Foundations of Bridges and Buildings," Jacoby and Davis, illustrates the application of the above formulas. Let Fig. 1 represent a section of wall footing on which the load is 64,000 lb. per lineal ft. and the allowable bearing on the soil 4,000 lb. per square foot. The width of footing will therefore be 16 ft. Designing the footing at three sections, a, 5½ ft. from the center, b, 3 ft. from the center and c, 1 ft. from the center, the shears will be, respectively, 10,000, 20,000 and 28,000 lb. and the bending moments, 150,000, 600,000 and 1,176,000 lb. in. Using an allowable fibre stress in the steel of 16,000 lb. per sq. in. and a maximum allowable stress on the concrete of 650 lb. per sq. in., reduced to an assumed value of 600 on the vertical plane, the value of R to be used in the formula $d = \sqrt{M/Rb}$ will be 95 (Principles of Reinforced-Concrete Construction, Turneaure and Maurer). From this formula the depth to the center of the steel at the points a, b and c will be, respectively, 11.5, 23 and 32.1 in. Using a depth of 6 in. at the outside the section shown in Fig. 1 will be adopted, as this makes all depths slightly larger than required. Tan $\alpha$ will be 26.25/84 = .312 and cos $\alpha$ = .954. Hence the allowable stress on the vertical plane is 650 x .954² = 590, which shows that the assumed value of 600 is satisfactory.

Using the formula $As = \frac{M}{f_s jd}$ the areas of the steel sections will be [illegible] 1.12 and 2.60 [illegible]. Using a bar spacing of 3 in. the required sectional area of each bar will be $\frac{2.60}{4}$ [illegible] $\frac{13}{16}$ [illegible] bar. As the required area is less at points a and b all bars [illegible].

The unit bond stress at c will be

$$u = \frac{28000}{[illegible]} - \frac{1{,}176{,}000 \times .312}{[illegible]} = [illegible]$$

and the diagonal tension will be

$$v = \frac{[illegible]}{b} = \frac{[illegible]}{12} = [illegible] \text{ lb. per sq. in.}$$

Had the regular formulas been used the values of the bond and diagonal tension would have been 76 and 82 lb. per sq. in. respectively.

To demonstrate the correctness of the above formula for bond it is evident that the difference in the total stress in the steel at sections b and c equals the total bond stress. As the unit bond at b is almost the same as at c, this total bond between b and c is $13 \times 45 \times 24 = 14{,}000$ lb. The difference in the total steel stress is $(2.59 - 1.72)\ 16{,}000 = 13{,}900$ lb., which checks closely with 14,000.

It will be noted that the shearing stress at the top is $f_c \tan \alpha = 590 \times .312 = 174$ lb. per sq. in. Although the shearing intensity is usually limited to 120 lb. per sq. in. this value is safe as the shearing strength of concrete is approximately one-half its compressive strength. It is only where the resultant of the horizontal and vertical shear results in a tension on oblique planes that the unit shear need be limited to 120 lb. per sq. in.

## Methods of Cold Weather Concreting at Troy Lock

In order to complete the Government lock and dam at Troy, N. Y., within the specified time it was found necessary to carry on concrete work in the lock during the winter of 1914-15. The various expedients employed to prevent damage to the concrete from the frost, were described by Mr. D. A. Watt, Assistant Engineer, in the September-October Professional Memoirs, from which the matter following is abstracted.

When the temperature fell below about 50° F., the sand, gravel and water used in the concrete were heated. A steam jet placed in the water tank of the concrete mixer sufficed to heat the water. The sand and gravel were heated by steam jets located at the bottom of the bins of the mixer. The steam, escaping upward through the mass, made this method very effective, even when the mixer was running to full capacity. When running slowly, however, it was sometimes necessary to reduce the supply of steam, as it made the concrete too hot for the men to work in the forms, and in confined forms resulted in so much vapor that the men could not see properly.

This method was also used on the construction of the dam, when toward the end of the working season the temperature fell below moderate. As the river water was shortly to be allowed to flow over the new section of the dam, it was necessary to harden the concrete rapidly, and this method proved very effective.

When the temperature fell below freezing, additional precautions were taken. Lighted lanterns were placed on top of the green monolith; and large improvised steam radiators, made of a few coils of 3-in. pipe, were hung close along the side of the forming; the whole was then covered with a paulin, and so left for about 48 hours. Loss of heat by radiation from steel forms is much greater than from wooden forms.

Concreting was carried on without special difficulty under occasional temperatures not far from zero, and the temperature of the concrete when delivered in the forms was rarely less than 60° F. The steam coils and tarpaulins were usually kept in place for about 48 hours, when the concrete had set sufficiently to allow the forms to be taken down. The lifts or thickness of courses ran from 3 or 4 to about 10 ft.

Difficulties also arose from the surface freezing of the sand and gravel storage piles, on which the cold would sometimes produce a frozen crust of a foot or more, hampering the operation of the excavating bucket. This was overcome by using steam pokers, consisting of 1¼-in. steam pipe about 10 ft. long pointed at one end and having a few small holes. Two or three of these would be worked into the storage pile over night near its base, its surface being covered with tarpaulins. The expenditure of a very small amount of steam would heat by morning all the material within several feet of the pokers, and melt all the adjacent frozen crust.

## Time-Saving Method for Investigating Old Railway Bridges for Heavier Loading*

It was formerly the common practice, when a new engine loading was up for consideration, to investigate all the light bridges involved. Stresses throughout the structure for this loading were figured and a decision then made as to whether or not the load could be handled safely. Each time a new loading came up for consideration the process was repeated and little or no use made of the previous computations.

The present practice on the Chicago, Milwaukee & St. Paul is to make an investigation or "classification" of each structure. Its carrying capacity is determined in terms of a standard series of train loadings. New engine and car loadings that come up for consideration are classified in the same series of standard loadings, and is then a matter of direct comparison to tell whether such proposed loadings can be handled over the various bridges safely. Every bridge which is known to be, or suspected of being, overloaded is thus classified.

In making these classifications it is necessary to establish the maximum unit stresses to which the various materials can safely be subjected. For the different materials these maximum safe stresses are taken as near the limit of strength of the material as is considered safe. The maximum safe stresses must be made low enough so there is no danger of the material yielding, altering its character or reducing the strength to carry loads after being subjected to this limiting stress for any number of times.

As an illustration of what may be considered as safe limiting unit stresses, the following are given and may be taken to apply where the design and physical condition of the structure are known to be first class:

| | Wrought iron. | Steel. |
|---|---|---|
| | Lb. per sq. in. | |
| Beams and girders, fiber stress in bending.. | 22,000 | 26,000 |
| Truss members, tension on net section...... | 20,000 | 24,000 |
| Timber stringers, fiber stress in bending...... | 2,000 | ...... |

(With suitable reduction for age for exposed timber over 6 or 8 years old.)

In fixing upon limiting unit stresses for loading old bridges, it is necessary to take into account: (1) the character of design, (2) the character of workmanship, (3) deterioration, (4) action under load, (5) speed likely to obtain over the structure and confidence as to the observance of any speed restrictions that may be imposed, (6) element of certainty as to the assumed loading being the maximum to which the bridge will be subjected, (7) importance of traffic, and the hardship which might result from temporary disablement of the structure, (8) the probability of early renewal on account of change of line, etc., (9) judgment based upon all of the factors surrounding the bridge, its location, service and condition.

In the systematic investigation of a large number of bridges, it is necessary to have a unit loading as a basis of comparison. The familiar Cooper's series of standard train loadings furnishes a convenient and well-known basis. On account of the fixed wheel arrangement for all the classes and the proportionality of wheel loads, it follows that the stresses in all parts of bridges on account of these loadings are directly proportional to the classes; that is, the stresses in every part of the structure, for Class E-50 loading will be just 50 times the stresses for Class E-1 loading.

In addition to the direct weight of the engine and carloads or live loads, certain other effects must also be taken into account. These include the impact action of moving loads, centrifugal forces which tend to throw a larger proportion of the load on the outside of the curve, and traction which is a force exerted along the track due to the traction of the locomotive or to setting the brakes on the train. In determining the maximum live loads which can be handled over any structure, it is necessary to make proper allowance for these extra effects of the live loads. It is also necessary to take account of the dead load stresses due to the weight of the structure itself and wind stresses due to the effect of wind pressure.

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*From a paper by C. F. Loweth, Chief Engineer, C., M. & St. P. Ry., presented Oct. 16 at the convention of the American Railway Bridge and Building Association.

The general method of investigating any part of the bridge and making a classification is as follows:

1. The maximum allowable stress is determined which, in the simpler cases, is the cross sectional area of the member multiplied by the limiting unit stress allowed.

2. Deduct from this the stress in the part due to dead load and wind load. The remainder gives the allowable stress for the live load effect.

3. Divide this by the stress for unit live load (Class E-1) which gives the classification for allowed live load, if at rest (train standing on the bridge).

4. Divide this classification by the term which takes into account the extra effects of the live loads, due to impact and centrifugal force, the result being the classification of the allowed live load at full speed.

As an illustration of this general method, assume that a bridge member has a sectional area of 8 sq. in. Also assume that the circumstances warrant the limiting unit stress of 24,000 lb. per square inch, so that the total allowable stress is 192,000 lb. Assume that the total dead load stress is 17,000 lb., and that the wind load is so small that it may be neglected. The total allowable stress available for the live load is then 192,000 lb. — 17,000 lb. = 175,000 lb. Assume also that the stress in the member for the Class "E-1" loading as determined by the usual method for computing stresses in bridges is 1,890 lb. The total allowable live load, if at rest is, therefore,

$$\frac{175{,}000}{1890} = E\ 92.1$$

Assume that the impact as determined by the ordinary formula for the given case equals 0.865 of the live load. Then if there is no centrifugal force and if LL represents the net live load at full speed

$$LL + 0.865\ LL = E\ 92.1$$

$$LL = \frac{E\ 92.1}{1.865} = E\ 55.2$$

which represents the classification of the member at the assumed unit stress.

The Class "E" loading above described, is an assumed typical loading. Actual engine and car loadings vary a great deal with the spacing of the wheels and the distribution of the weight on the various wheels. The effects of various loadings on bridges are not in direct proportion to the weight of the engine or cars, but depend on the number of wheels, the spacing of the wheels, the distribution of weight, etc. Actual engine loadings can, however, be reduced to equivalents in the standard train loadings corresponding to the different span lengths.

This is done by computing the maximum bending moments and end shears for the given train loading for each span length. These are divided by the maximum bending moments and end shears for the unit Class "E-1" loading for the corresponding span, the result being the classification of the loading. As an illustration of classifications of various loadings a diagram is given which shows the classification of several of the new United States standard locomotives.

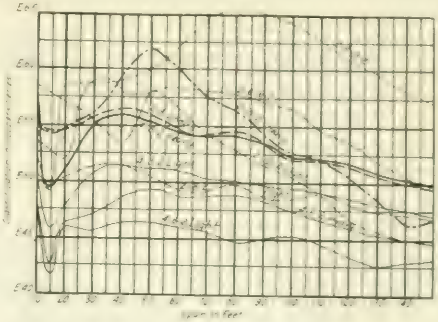
In the foregoing, the classification has been determined with an allowance for the effect of the maximum speed over bridges. Where speed is reduced the effects of the live load are much less and the allowance for impact and centrifugal forces, if any, may be correspondingly reduced. This will permit heavier loadings to be operated at reduced speed than at full speed. From the tests conducted by the American Railway Engineering Association, it is found that the maximum impact which will be obtained at reduced speed is:

[illegible]
[illegible] hour
[illegible]
[illegible] hour.

Where the classification of the bridge indicates that some loadings which might be desired to run cannot be handled at full speed, the classification for certain reduced speeds should be worked out.

An inspection of the diagram indicates that the effective span of the bridges and the characteristics of the engine loadings determine in a very large way whether or not the given loading can be run over the bridge, and that it is unsafe to base such comparisons merely on a percentage of the total weight. Unfortunately it is assumed by some officers that the effect of all locomotives of the same total weight is the same. If this practice must be resorted to, the limits set must be on a very conservative basis, otherwise there will be danger of producing unsafe conditions. This practice also would not be economical because it might lead either to the premature renewal of some bridges or to the unnecessary ruling off of certain types of engines.

In older bridges there are certain parts where low classification can usually be expected. These have been found to occur most often in the lightest members of the structure and members which carry the smallest dead load stresses. Thus it is found that the floor systems of bridges have generally a lower classification than girders or the chords of trusses.



Classification of New U. S. Standard Locomotives

The low classification of stringers is generally in the section of the flanges near the center, in the riveting in flanges near the ends of stringers, particularly if they are shallow, and in the riveting in connections of the stringers to the floor beams. In plate girders the flanges frequently show low classifications at points where the web is not fully spliced near the center and at points near the ends of cover plates. The flange riveting near the ends of girders frequently has a low classification, particularly where the girders are shallower at the ends. Webs of plate girders show low classification near the ends of the girders where there is a relatively large expanse of web, unsupported by stiffeners. The web splices near the end of the span have a low classification where only one line of rivets is used in each side of the splice.

In trusses, the posts and diagonals near the center of the span usually show a low classification. This is particularly true of the diagonals and counter-diagonals of light eye-bars or loop rods. Suspenders, or hip vertical members, frequently have a low classification. The classification of end posts at top chords of truss bridges is frequently low on account of the eccentricity of the member with respect to the location of the pin.

The pins of old truss bridges frequently show a surprisingly low classification where computations are made in accordance with the usual methods and it is necessary to take advantage of certain conditions which are more favorable than the usual assumption to help out the classification. In timber truss bridges the lowest classification usually occurs in the floor beams, truss rods and diagonal braces.

It has been found that metal bridges suffer frequently from corrosion at the top flanges of stringers and floor beams on account of the action of brine drippings from refrigerator cars. In bridges where ties are supported on shelf angles riveted to the web of the girders, the shelf angles frequently show considerable corrosion and tend to break at the root of the angle. In pin connected trusses, excessive wear sometimes takes place in the pin bearings, particularly in drawbridges.

Possible deterioration of the structure of the metal itself has been a matter of apprehension in some quarters, but it now seems to be recognized that no such integral deteriorating action takes place where the bridge has not been subjected to excessively high stress. If crystallization is found in the metal of a structure, it probably was there at the time the structure was built, on account of improper methods of manufacture of the material. It may, therefore, be taken as a certainty that iron and steel bridges, if not reduced in section by rust, etc., and if not shaky on account of inadequate bracing, are fully capable of carrying the figured loads at reasonable limiting unit stress provided they are carefully inspected and properly maintained.

## U. S. Employment Service Establishes Community Labor Bureaus for Soldiers and War Workers

With the cooperation of the national welfare organizations, the government agencies interested in demobilization, and local community organizations of all kinds, the United States Employment Service is establishing a Bureau for the returning soldiers, sailors and war workers in every city and town in the United States. It also has stationed qualified representatives in all army camps and posts in this country to acquaint soldiers with the facilities for assisting them to suitable employment after they leave camp. The reconstruction program of the Employment Service links up all national and local efforts, both governmental and private, and centralizes in every community, through these local bureaus, all information as to proper openings in industry, commerce and agriculture available to the nation's fighters and war workers. The cabinet officials most concerned with demobilization have taken steps to keep intact the field machinery of the defense council so that it may be utilized by the Department of Labor and its Employment Service in carrying out the replacement program. Their action brings to the Employment Service's aid a total of 184,000 local units, among them being the State Councils, 4,000 community councils, and 16,000 women's organizations.

## Building Construction to Promote Employment and Stimulate Industry

For the next year or two we will be passing through a stage of transition in connection with trade, commerce, immigration, labor and all forms of industry. There will also be changes in economic conditions from the present somewhat artificial state caused by the war. How to stabilize industrial conditions, provide employment in reproductive undertakings and spend every dollar to the best advantage in building up the country is the supreme task of the next few years. There would appear to be no doubt that, by whatever means it is to be accomplished, the stimulation of building is one of the best methods of promoting employment and stimulating industry. It will be particularly valuable as a means of employing men displaced as a result of cessation of industries which have been engaged in war production, and returned soldiers. Besides forming a field of employment of these classes it will assist the returned soldier in obtaining cheaper and better shelter for himself and family in proximity to his place of employment. Under present conditions returned men will find it almost impossible to obtain suitable accommodation and this may give rise to serious discontent.—Thomas Adams, Town Planning Advisor, Canadian Conservation Commission, in an address at the 7th National Conference on Housing.

## Steel Makers' Select List of Standard Ship Shapes

Two conferences of importance to shipbuilders and steel makers were held in Philadelphia recently. At the first the steel makers took action looking to modification in rolls to produce ship channels and shipbuilding bulb angles. Later the steel makers and representatives of the Emergency Fleet Corporation conferred on a revision of the

TABLE I.

Dimensions in Inches.

Bulb Angle Weights, Approximate.

EQUAL LEG ANGLES.

| Size | Thickness. | Wt. per ft. | Size. | Thickness. | Wt. per ft. |
|---|---|---|---|---|---|
| 6 x 6 | .750 | 28.7 | 3½ x 3½ | .625 | 13.6 |
| | .6875 | 26.5 | | .5625 | 12.4 |
| | .625 | 24.2 | | .500 | 11.1 |
| | .5625 | 21.9 | | .4375 | 9.8 |
| | .500 | 19.6 | | .375 | 8.5 |
| | .4375 | 17.2 | | .3125 | 7.2 |
| | .375 | 14.9 | | .250 | 5.8 |
| 5 x 5 | .750 | 23.6 | 3 x 3 | .500 | 9.4 |
| | .6875 | 21.8 | | .4375 | 8.3 |
| | .625 | 20.0 | | .375 | 7.2 |
| | .5625 | 18.1 | | .3125 | 6.1 |
| | .500 | 16.2 | | .250 | 4.9 |
| | .4375 | 14.3 | | | |
| | .375 | 12.3 | 2½ x 2½ | .375 | 5.9 |
| | | | | .3125 | 5.0 |
| 4 x 4 | .750 | 18.5 | | .250 | 4.1 |
| | .6875 | 17.1 | | | |
| | .625 | 15.7 | 2 x 2 | .250 | 3.19 |
| | .5625 | 14.3 | | .1875 | 2.44 |
| | .500 | 12.8 | | | |
| | .4375 | 11.3 | | | |
| | .375 | 9.8 | | | |

UNEQUAL LEG ANGLES.

| Size | Thickness. | Wt. per ft. | Size. | Thickness. | Wt. per ft. |
|---|---|---|---|---|---|
| 6 x 3½ | .750 | 22.4 | 4 x 3 | .500 | 11.1 |
| | .6875 | 20.6 | | .4375 | 9.8 |
| | .625 | 18.9 | | .375 | 8.5 |
| | .5625 | 17.1 | | .3125 | 7.2 |
| | .500 | 15.3 | | | |
| | .4375 | 13.5 | 3½ x 3 | .500 | 10.2 |
| | .375 | 11.7 | | .4375 | 9.1 |
| | | | | .375 | 7.9 |
| 5 x 3 | .500 | 12.8 | | .3125 | 6.6 |
| | .4375 | 11.3 | | .250 | 5.4 |
| | .375 | 9.8 | | | |
| | .3125 | 8.2 | 3 x 2½ | .375 | 6.6 |
| | | | | .3125 | 5.6 |
| | | | | .250 | 4.5 |

BULB ANGLES.

| Size. | Thickness of longer leg. | Wt. per ft. | Size. | Thickness of longer leg. | Wt. per ft. |
|---|---|---|---|---|---|
| 10 x 3½ | .725 | 35.2 | 8 x 3½ | .550 | 23.2 |
| | .675 | 33.2 | | .500 | 21.6 |
| | .626 | 31.1 | | .450 | 19.6 |
| | .575 | 29.1 | | .400 | 18.0 |
| | .525 | 26.9 | | | |
| | .475 | 24.9 | 7 x 3½ | .525 | 20.0 |
| | | | | .475 | 18.6 |
| 9 x 3½ | .625 | 28.6 | | .425 | 16.8 |
| | .575 | 26.6 | | .375 | 15.3 |
| | .525 | 24.8 | | | |
| | .475 | 22.7 | 6 x 3 | .475 | 15.6 |
| | .425 | 20.9 | | .425 | 14.1 |
| | | | | .375 | 12.8 |
| | | | | .350 | 12.2 |

SHIP CHANNELS.

| Size. | Thickness. | Wt. per ft. | Size | Thickness. | Wt per ft. |
|---|---|---|---|---|---|
| 12 x 3½ | .700 | 40.8 | 8 x 3½ | .525 | 25.3 |
| | .600 | 36.8 | | .425 | 22.6 |
| | .500 | 32.7 | | .375 | 21.2 |
| | .450 | 30.6 | | | |
| | | | 7 x 3½ | .500 | 22.5 |
| 10 x 3½ | .675 | 34.8 | | .400 | 20.1 |
| | .575 | 31.4 | | .350 | 18.9 |
| | .475 | 28.0 | | | |
| | .425 | 26.3 | 6 x 3½ | .475 | 19.8 |
| | .375 | 24.6 | | .375 | 17.8 |
| | | | | .325 | 16.8 |
| 9 x 3½ | .650 | 31.3 | | | |
| | .550 | 28.3 | 6 x 3½ | .350 | 15.2 |
| | .450 | 25.2 | | | |
| | .400 | 23.7 | | | |

| TEES. | | | HATCH ZEE (Tyzack). | | |
|---|---|---|---|---|---|
| 6½ x 6½ | .450 | 19.8 | 2½ | .500 | 13.6 |

15-IN. STRUCTURAL CHANNELS.

| Thickness. | Wt. per ft. | Thickness. | Wt. per ft. |
|---|---|---|---|
| .818 | 55 | .524 | 40 |
| .720 | 50 | .426 | 35 |
| .622 | 45 | .400 | 33 |

27 shapes—115 sections.

American standard practice and recommended a selected list of structural shapes most suitable for ship construction. The following account of those conferences and the action taken are abstracted from the Emergency Fleet News, the official publication of the U. S. Shipping Board Emergency Fleet Corporation.

On July 2, 1917, representatives of the companies named met in Washington with representatives of plate manufacturers and adopted a standard practice recommended by American steel makers and subsequently adopted by the Fleet Corporation as a guide to the shipyards in placing orders with the mills for ship steel. The effect of the standard practice has been to eliminate minute variations in the thickness of plates ordered from the mills and to simplify the transmission of orders from the yards to the mills. The situation has improved so greatly as compared with previous practice that the plate mills have been able to make a remarkable production record.

At the time that the standard practice was adopted no selected list of structural sections was prepared and it was only recommended that in general the use of sections rolled infrequently be eliminated and that orders be confined so far as possible to American standard beam sections, American standard structural channels, and plain angles, provided, however, that ship channels and bulb angles might be rolled if required on shipbuilders' schedules. The limitation in the use of ship channels and bulb angles was due to the lack of adequate manufacturing facilities and it was the desire of the steel makers to make as broad as possible the allocation of ship steel to all makers.

The conferences were held in the offices of the Cambria Steel Co., with George E. Dix, assistant to the General Manager of Sales, in the chair. R. B. Woodworth, advertising manager and Engineer of Carnegie Steel Co., who had been instrumental in the preparation of the original standard practice, presented suggestions as a basis of discussion for the modification and standardization of ship channels and bulb angle sections and for the revision of the American standard practice.

It was decided by the steel makers that inasmuch as the British standard sections of ship channels and shipbuilding bulb angles appeared to be better adapted to economical manufacture than the American standards, and inasmuch as the new rolls which had been turned in recent years to produce those sections conformed in general to British standards, hereafter American standards should be discontinued and rolls in hand not to British standards should be redressed at as early a date as possible to roll such sections as closely to British standards as slightly divergent methods of production would allow; particularly in view of the further fact that the adoption of British standard sections would enable American mills to compete on an even basis for ship steel wherever utilized in shipyards either at home or overseas.

Careful consideration was then given to a selected list of structural shapes to be recommended for ship construction, together with those modifications in the standard practice which the experience of 16 months indicated to be desirable. These were further discussed at the second conference with representatives of the Emergency Fleet Corporation, and it was further recommended to the Emergency Fleet Corporation that as soon as possible a technical order be issued to all shipyards to put these recommendations in effect, and that so far as possible orders for structural sections to be used in ship construction be governed by the recommended list appearing in Table I.

Sections not shown in this list may be included on shipbuilders' schedules with the proviso that they be specified only when they can be ordered in lots of not less than 40,000 lin. ft. per shape at one time, or by special arrangement with the mills. Orders for such shapes should not be divided among mills, but entire quantity of each shape should be placed at one mill with the express stipulation that that mill may, at its option roll, ship and invoice all the tonnage at one time, regardless of position in shipyards and fabrication schedules.

# Methods of Strengthening Old Railway Bridges*

The strengthening of light bridges may be either a matter of reinforcing minor details which are found to limit the carrying capacity of the bridge, or may consist of heavy reinforcing in an attempt to increase the strength of the structure throughout.

The minor strengthening can usually be done at small expense and is an economical method of getting considerably greater lives out of bridges. Heavy reinforcing may or may not be economical as it involves doing work in the field which is expensive, while the maintenance of traffic during the time the work is in progress, which involves some risk to traffic, is unusually expensive. On very large bridges where the cost of replacing amounts to a very large sum, some very extensive strengthening operations have been carried out economically. In making plans for reinforcing bridges, it is usually preferable to add new material to the structure so that the existing structure is not temporarily weakened, rather than to remove parts and substitute heavier ones, though the latter must sometimes be done.

In plate girders the top and bottom flanges may be strengthened by additional cover plates, particularly at points where the web is spliced and not effective for carrying its proportion of the bending stress. Where there are no cover plates on the girders, cover plates of desired length can be added. Plate girders can be doubled up to make deck spans, using three or more girders per span at small expense, thereby using up light girders and providing bridges of large carrying capacity. Where waterway or other undercrossing conditions permit, timber bents can be placed under spans to strengthen them.

Where the rivets in the flanges of girders show low classification, larger rivets can be substituted, or, where the rivet spacing permits, additional rivets can be driven. Where the web plates give a low classification, additional stiffeners can be placed in the panels near the ends of the girders to give additional support to the web. Shelf angles can be strengthened by short vertical stiffeners beneath them. Where web splices with low classification occur, these can be replaced with wider splice plates with additional rows of rivets in the splice.

In through bridges the stringers can be reinforced by additional riveting, by the placing of additional stringers either timber or steel, and by shifting existing stringers to secure better distribution of the load. Where stringers are spaced so that some stringers do not carry their full proportion of load, it is possible to introduce cross bracing so that all the stringers in the panel act together to carry the load.

Floor beams can be reinforced by cover plates or angles added to the flanges by additional riveting, or by shifting the stringers toward the trusses to reduce the bending in the floor beams. In very old bridges, floor beams are frequently of much lower classification than the remainder of the bridge and can sometimes be replaced with entirely new floor beams at a reasonable expense so as to get additional life out of the remainder of the structure.

In trusses the diagonals and counters can usually be reinforced with additional bars or rods with loops over the truss pins and connected by turnbuckles to provide adjustment. Similarly, bottom chords of eye-bars can be reinforced with additional bars with yokes bearing on the heads of the original eye-bars.

End posts of through bridges, having low classification due to eccentricity can be strengthened by placing angles or plates on the sides of the members so as to reduce the eccentricity.

Where pins have low classification, it is sometimes possible to move the members on the pin to reduce the bending. In some cases, diaphrams placed inside of built-up numbers will relieve bending on the pin. The pins themselves can be strengthened by replacing with high carbon or special alloy steel pins of the same size, or if additional strength is required, by boring out the pin holes and putting in larger pins.

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*[illegible] paper by C. F. Loweth, Chief Engineer, C. M. & St. P. Ry., presented at the [illegible] annual convention of the American Railway Bridge and Building Association.

The cost of strengthening bridges varies with the size of the job, the amount of staging required, the amount of shifting of members required to reach different portions of the work, the size of the crew available, the distance traveled by the crew, the tools available, etc. In a general way, it has been found that the cutting out and replacing of rivets on ordinary strengthening jobs costs from 25 cents to 75 cents each and drilling and driving new rivets 50 cents to $1 each; that is, the cost of such work will be given by the total number of rivets driven at these unit prices, plus the cost of additional material required.

With the maintenance of old and light capacity bridges, the question continually arises whether it is more economical to strengthen the structure or renew it. As a general proposition it would be permissible to spend each year for strengthening an amount equal to the interest on the investment in a new bridge, less the cost of the additional maintenance required by the old bridge on account of the greater attention it receives.

## Air Tool Devices

Three convenient air tool devices developed by Mr. W. A. Mason, foreman air tool repair shop, Wyandotte plant of the American Shipbuilding Co., Detroit, Mich., are described in a recent issue of the Emergency Fleet News. The devices are as follows:

**Repairing Vise for Air Drills.**—Figures 1, 2 and 3 show a special vise or holder for air drills while repairs are being made.

It consists mainly of a round vertical standard or shaft with attached base plate for bolting to the work bench, and a double clamping block or head mounted on the standard and carrying a horizontal bearing sleeve. A shouldered mandrel is held in the sleeve and provided with a threaded split collar on the end opposite the shoulder to prevent end play and to give any desired rotary tension. The opposite end of the mandrel is fitted with a threaded stud which is to be screwed into the dead handle side of the air drill.

The universal features of the vise with clamping arrangements for all adjustments makes it easy to hold the air drill in any position desired and to make changes from one position to another with the least possible loss of time.

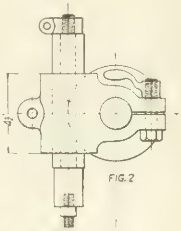


FIG. 2

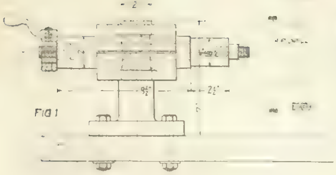


FIG 1

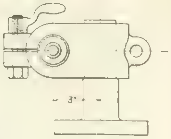


FIG 3

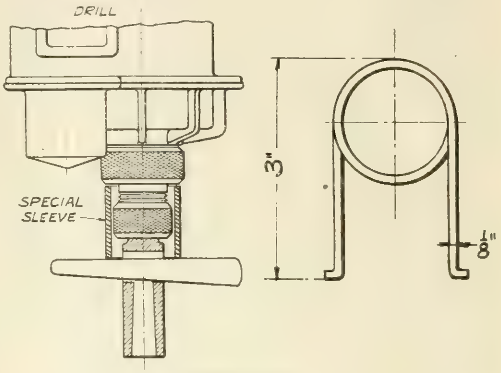
**Air Drill Socket Extractor.**—Figure 4 illustrates a very simple method of removing a taper shank drill socket from certain classes of air drills which are not provided with a more convenient extracting arrangement.

A hardened tool steel sleeve constitutes the special device used for this purpose, and is made large enough to slip loosely over the protection nut of the drill spindle so that it can rest on shoulder against the face of the packing nut. The length of the sleeve is such as to partially overlap the drift key slot in the drill socket.

A key driven into the slot and bearing against the sleeve will force the socket out of the drill spindle.

**Air Drill Valve Extractor.**—Figure 5 shows a device for extracting valves from air drills, it being made of No. 11 B. & S. Gauge spring steel wire.

When used the bent points or hooks are inserted into the main parts of the valve and a piston or drift plug is inserted from the opposite end until it rests against the heels of the hooks which are as driving lugs for the removal of the piston by tapping lightly on the plug.



Figs. 4 and 5.

This obviates damage to valve and block resulting from the usual practice of using cold chisel against the valve for its removal.

## Considerations in Selection of Paint

In a paper presented at the recent convention of the Maintenance of Way Master Painters' Association Mr. G. W. Thompson, chief chemist National Lead Co., pointed out that paint specifications for railroad stations have been complicated and bewildering. He urged a simplification of formulae and simplifications of color schemes. This lack of simplicity was due, in his opinion, to a failure to appreciate some of the simpler points of paint designing. Some of these points were outlined as follows:

Take the question of the durability of paint. As paint is made of vehicle and pigment, the question we should ask is to what extent is the durability of paint dependent upon the pigment or upon the vehicle, or both. It is obvious that pigment alone will not protect. It is equally obvious that oil alone will not protect, and yet it is perfectly true that pigment does not decay appreciably and that paint decay is due to the destruction of the oil present. These facts have led to two different conclusions. One is that as it is the oil that decays, the more oil in a paint the longer it will last. The other is that inasmuch as it is the oil that decays, durability is obtained by the protective action of the pigment.

There is a popular demand for high gloss finishing paints. I think this is a mistake. Very few paints having a high gloss, except enamel paints, will retain that gloss satisfactorily for more than a year. High gloss is generally obtained by an excess of oil, and my experience has shown that a high gloss paint at the end of one year will as a rule have much less gloss than a plant which had a semi-gloss at the beginning.

I would also direct your attention to the question of color and color schemes. You compare two paints and you see a difference. Is the difference trivial or is it a substantial one? Placed side by side the difference appears to be great. Separate the two paints a short distance from each other and you may not be able to see the difference. Apply these two paints to two different buildings and they may give equally satisfactory results insofar as the color effect is concerned. In judging of colors there ought to be some means of comparing them that will allow for considerable differences so long as those differences do not substantially affect their practical use.

One other fundamental proposition should be considered in designing paint. All paints intended for decoration should be of colors that have no jarring effect upon the eye. All paints when applied, to get the best artistic results, should blend in harmony with all other colors which may come to the eye from the same general source. What I have had to say with regard to color may be summarzied this way: Look only for substantial differences in color. Do not select colors that jar with each other, and do not demand pure whites except for line effects, but always have them tinted to harmonize with color environment.

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# The Corrosion of Iron and Steel, with Special Reference to Reinforced Concrete*

In an article in The Architect and Engineer, Dr. J. Newton Friend, describes the causes of rusting of iron and steel and suggests methods for preventing the corrosion of the reinforcing metal in concrete. Extracts from this article follow.

According to Bauermann, when iron rusts it expands to some 10 times its original volume. This may possibly be somewhat of an exaggeration, but the fact remains that very appreciable expansion does take place on rusting, a property that is made use of by the plumber in his rust joints. This expansion is, to the worker in ferro-concrete, a serious problem. If the metal once begins to rust a cracking of the concrete is inevitable; more air and water enter so that corrosion now proceeds apace, and the structure becomes proportionately weakened.

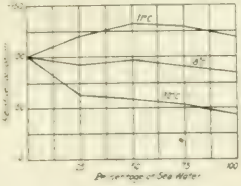

Fig. 1.

The influence of aqueous solutions of inorganic salts upon the corrosion of iron depends upon a variety of factors such as, for example, the chemical nature of the salt, its concentration and the temperature of the solution.

At ordinary temperatures a very dilute solution of sodium carbonate is considerably more corrosive than tap water. But if the concentration be increased to 0.25 per cent and above, the metal is entirely protected from rusting. Similarly, a 3 per cent solution of common salt at about 10° C. is much more corrosive than tap water at the same temperature, but as the temperature rises the relative corrosivity falls, so much so that at 21° C. the solution is appreciably less corrosive than tap water. Since sea water contains some 3 per cent of sodium chloride it is of interest to inquire into the effect upon its corrosive powers of diluting it with river water, for this occurs in nature at the mouths of many rivers and has to be reckoned with by the engineer.

This is well illustrated by Fig. 1. The broken line represents the loss in weight, due to corrosion, of iron in tap water. This, for the sake of simplicity, is taken as 100 for each temperature studied. It will be observed that at 18° C. (64° F.) and above all dilutions of sea water are less corrosive than tap water, whilst at lower temperatures they are more corrosive.

Figure 2, showing the relative corrosive action of sea water at various temperatures, is very interesting. At 11° C. sea water is considerably more corrosive than tap water. At 13° C. the two waters act similarly, whilst at all higher temperatures sea water is less corrosive than tap water.*

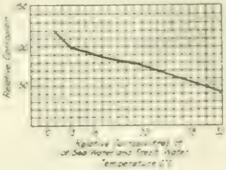

Fig. 2.

**Means of Preventing Corrosion of Iron.**—The preservation of iron in concrete may be effected in one or more of three ways, namely:

1. By complete exclusion of air.
2. By complete exclusion of water.
3. By rendering the concrete sufficiently alkaline to place it within the inhibiting area.

If the engineer can make his concrete conform perfectly to any one of these conditions he has achieved his object, for the reinforcing metal will not rust. Unfortunately, in practice, materials cannot be relied upon to yield perfect results and the engineer's best policy is to conform as nearly as is reasonably possible with all three conditions. In this way he may hope so to reduce the tendency to corrode as to render it negligibly small within finite time.

The following considerations suggest themselves as worthy of careful study:

1. None of the concrete materials should be too coarse, otherwise thorough mixing and good contact between the different ingredients will not be as perfect as is desirable.

2. It is essential to press or run the mixture well into position in order to eliminate voids in so far as as possible. It is obvious that voids tend to increase permeability to water and air and are in consequence highly dangerous.

3. A sufficient thickness of concrete should be applied to the metal. If too thin the concrete may not be sufficiently imprevious or it may crack mechanically and thus admit air and water to the metal.

4. Stray electric currents must be avoided. If the metal should become anodic, rusting would take place in consequence of the liberation of oxygen, and this, leading to cracking, would rapidly destroy the cement.

5. Substances likely to contain acids or acid producing bodies should be avoided. Coke breeze and slags are cases in point, as they frequently contain injurious sulphur compounds.

6. The concrete may be advantageously coated with some waterproofing material to render it still more impervious, provided such proofing is entirely free from acid or acid-producing substances.

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* **Concrete Shipbuilding at Christiansand.** The Sorlandske Staalbeton Skibsbyggeri A. S. at Vanse, near Farsund, in the Christiansand district, according to a report of the U. S. Consul at Christiansand, has launched its first concrete boat, a 250-ton lighter, and has on its docks a second vessel of similar dimensions ready to be launched. The company has also under construction a 600-ton vessel, which will be equipped with a 320 H.P. Bolinder engine, and a 1,000-ton vessel, to be equipped with a 360 H.P. Diesel motor.

## Essentials of Industrial Housing Standards of Federal Government

The important features of the standards recommended for permanent housing developments by the U. S. Bureau of Industrial Housing and Transportation were summarized as follows by Mr. John Nolen, Town and City Planner, in an address delivered Nov. 2d at the 7th National Conference on Housing:

**The House Itself:** The most important features in determining the character of the house itself are:

Row or group houses are not to be more than two rooms deep.

Cross ventilation as direct as possible is to be provided for all rooms.

No living quarters are to be in basements.

A minimum clear space of 8 in. is to be provided between the ceiling and the roof, with adequate ventilation.

Five-room houses are to be preferred for higher paid workers, and four-room houses for lower paid workers.

Every house is to have one large bedroom and a parlor or living room from 10 x 12 feet to 12 x 14 feet in size.

**Town Planning.**—In the town planning features the regulations of most far reaching effect are:

Side yard space between adjacent buildings is to be preferably 20 ft., with a minimum of 16 ft.

The group house should be used wherever lot sizes or land values make it difficult or impossible to provide adequate size yard space.

Rear yard depth is to be not less than the height of building, nor in any case less than 20 ft., and the minimum distance between the backs of houses at least 50 ft.

Front yards or setbacks are desirable where practicable, and the minimum distance from the front of the house to the front of the opposite house is to be 50 ft.

Private alleys will not be accepted, but this access to the rear of houses may be made through minor public streets, such streets to be not less than 12 ft. wide, and to be properly paved, curbed, drained and lighted.

The tenement and apartment house is to be considered an undesirable house type, and accepted only in places where other types are not practicable.

## Rigidity of Riveted Joints of Steel Structures

In analyzing the stresses in a rectangular frame, it is customary to assume that the connections are rigid. If the connections are not perfectly rigid, it is evident that the actual stress may not be equal to the computed stress. Tests to determine whether serious error is introduced into computations for stresses in steel frames by the assumption that the joints are perfectly rigid have been completed by the Engineering Experiment Station of the University of Illinois under the direction of Wilbur M. Wilson, Assistant Professor of Civil Engineering, and Herbert F. Moore, Research Professor of Engineering Materials. The test pieces used were connections which are types common in engineering structures and which resist loads and moments by methods fundamentally different. The connections were tested in pairs in a 300,000-lb. Olsen four-screw testing machine. Results of the tests are given in detail in Bulletin 104 entitled, "Tests to Determine the Rigidity of Riveted Joints of Steel Structures." Copies of the Bulletin may be obtained without charge by addressing the Engineering Experiment Station, Urbana, Ill.

## Personals

**E. P. Bridges**, for the past 6 years clerk and treasurer of Griffin, Ga., has been appointed city manager.

**W. C. Marion** has been appointed county engineer of Yakima County, Washington, succeeding Lieut. O. E. Brashears, now at Washington, D. C.

**William F. Schepflin**, consulting engineer for the Modern Construction Co. of Fremont, O., has been appointed county surveyor, succeeding the late Earl M. Millious.

**Miles Standish**, of San Francisco, has been appointed a member of the California State Board of Harbor Commissioners. He succeeds John H. McCallum, the latter becoming president, vice Arthur Arlett, resigned.

**Mark D. Feinknopp**, who has been at the officers' training camp at Fort Monroe, Va., has resumed his duties as general manager of the Federal Construction Co., Columbus, O.

**La Verrie J. Ruddock**, recently stationed at Camp Humphreys, Va., received a discharge as captain of engineers U. S. Army, Dec. 5, and has been appointed city engineer of Wheaton, Ill.

**Albro Gardner**, Albro Gardner, Jr., and A. H. Fischer have organized under the firm name of Gardner, Gardner & Fischer and have opened offices at 411 Lyon Bldg., Seattle, Wash., where they will engage in engineering practice.

**Arnold W. Brunner**, of New York, city planner, and president of the Fine Arts Federation of New York, has been appointed chairman of a committee of artists and architects to draft a bill for the next session of the New York legislature, which would create a state art commission to aid municipalities and localities in the selection of proper war memorials.

**F. L. Hinman** has been appointed mechanical engineer of The Sheffield Co., of Sheffield, Ala. This company, which is under the management of The J. G. White Management Corporation, New York City, furnishes street railway transportation, electric light and power, and water service in Sheffield, Tuscumbia and Florence, Ala. For a number of years Mr. Hinman was master mechanic of the New York State Railways, Syracuse lines. He left the employ of that company in the early part of this year, to become associated with the United States Ordnance Department, with headquarters at Watervliet arsenal, Watervliet, N. Y., in which service he was engaged up to the time of his present appointment.

## Obituaries

**Henry Wood**, a contractor of Taunton, Mass., died Dec. 15, aged 88.

**Lezin A. Amirault**, a building contractor of Phoenix, Ariz., died Dec. 9, aged 62.

**George Morton Walker**, a pioneer civil engineer of Kansas, died Dec. 14 at Salina, Kan., aged 88.

**A. R. W. Speiry**, for the past 2 years chief engineer of the Anderson-Cottonwood Irrigation District, Anderson, Cal., died Dec. 6, aged 29.

**Benjamin Palmer Carter**, for the past 20 years consulting engineer and general manager of the Robertson Deep Mine in the Rand section of South Africa, died Dec. 4, aged 46. He was educated at Tulane University and finished as an engineer in the Columbia School of Mines in New York.

**T. M. Chapman**, superintendent of Fire Prevention, Central of Georgia R. R., Savannah, Ga., died on Dec. 4th of pneumonia following influenza. He was 45 years of age and was born at Oberlin, O. Almost all of his engineering experience was on railroad maintenance and construction. At the time of his death he was a member of the National Board of Directors of the American Association of Engineers and president of the Savannah Chapter of that Association.

**L. H. Weideman**, vice-president of the Waterloo Cement Machinery Corp., Waterloo, Ia., died Dec. 15 at the American Hospital, Chicago, of lobar pneumonia. Mr. Weideman went to Chicago a week ago on business and was taken ill while at the La Salle Hotel and removed to the hospital. He had been associated with the Waterloo Cement Machinery Corporation since its organization in 1909. Starting with that institution as a bookkeeper, he had advanced to the position of general sales manager.

**Leo H. Robbins**, general manager of the Dunn-McCarthy Co., Chicago, died Dec. 16, aged 38. Mr. Robbins started in the construction field as a water boy and worked his way up to foreman. Later, in his 18th year, he became superintendent and was known as the "boy superintendent." He came to the Dunn-McCarthy Co. eight years ago and became their general manager and was considered by them to be the best all-around man in the construction field. He had charge of the construction of the Pennsylvania Railroad from Ben Davis to Frankfort, Ind., and the different chief engineers of railroads spoke very highly of him.

## Trade Publications

**A. S. Cameron Steam Pump Works**, 11 Broadway, New York, has issued a 12-page bulletin on pumps for Marine Service. The bulletin shows sectional and complete views, as well as description and tables.

**The Milliken Brothers Mfg. Co., Inc.**, Woolworth Bldg., New York, has just published a new illustrated book entitled "Space and Speed in Steel Buildings," giving a description of the "Standardized Truss Unit System" of building construction, designed and manufactured by the company. The book shows a number of interesting half-tones, illustrating different buildings of this type constructed for the United States Government. Copies may be obtained free from the company by those interested.

## Industrial Notes

**H. W. Clarke**, who until Dec. 15 has been connected with the advertising service department of the McGraw-Hill Company at Chicago, has been appointed manager of advertising for the Chicago Pneumatic Tool Co., Chicago, Ill. Mr. Clarke has been identified with the engineering advertising field for several years. Prior to his connection with the McGraw-Hill publications he spent eight years with the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., part of the time as a member of the sales and publicity departments and later as western publicity representative with headquarters at Chicago.

**The Milwaukee Corrugating Co.**, manufacturers of sheet metal products, Milwaukee, Wis., presented all its salaried employees who had been in the service of the company at least one year with one month's salary as a bonus. Employees who had been with the company less than one year received a pro rata on their month's salaries.

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